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THE PHILIPPINE SPECIES OF NEPENTHES

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In recent years it has been shown that the family Nepenthaceæ has a considerable development in the Philippine Islands. The most-primitive species of the group seems to be *Nepenthes pervillei* of the Seychelle Islands but, from a geographic standpoint, Borneo is now the richest area, as it contains twenty-five of the seventy known species. *Nepenthes alata* and *N. ventricosa* were the two species first described from the Philippines by Blanco in 1837. Since that time the number has been increased to ten or possibly eleven, of which two species, *N. merrilliana* and *N. truncata*, rank among the most striking of the genus *Nepenthes*, which alone constitutes the family Nepenthaceæ.

It is highly probable that, when the more-isolated parts of the Archipelago are thoroughly explored, several additional species may be secured. Meanwhile it seems desirable to present a synoptic review of the known species; the following is based on my monograph of the genus: [1]

Genus NEPENTHES Linnæus

Subshrubby or shrubby plants, of erect, climbing, branching habit, rarely becoming partially or wholly epiphytic. Stem 0.5 to 2 m, or sometimes 8 to 10 m high, by 10 to 25 mm thick, cylindric to trigonous, glabrous to hirsute. Leaves closely to distantly disposed along the stem, each usually divided into

[1] Engler's Pflanzenreich 36 (1908) 1–92, figs. 1–19.

petiole, basal lamina, excurrent midrib or tendril, distal lamina developed as flaps or ridges in front of inflated pitchered midrib, pitchers with, rarely without, doubly inflexed corrugated rim, and surmounted by fused laminar lobes in the form of a lid that springs from near a small slender spur that is the organic leaf apex. "Alluring" honey glands often abundant over the above parts, except the inner lid surface and edge of the corrugated rim, where "attractive" honey glands are numerous; pitcher interior wholly glandular, shining and forming "detentive" and digestive surface, or upper third to half glaucous, smooth, nonglandular, and "conducting" for insect prey.

Inflorescence 10 to 130 cm long, rarely a raceme of cymes, usually a simple raceme. Axis, pedicels, and exterior of sepals often villous to hirsute. Pedicels rarely many, usually two- to one-flowered. Flowers diœcious, tetramerous, rarely trimerous, small. Sepals 4, rarely 3, lanceolate to subcircular, densely glandular within, green or greenish yellow to purple. Stamens 24 to 4, commonly 12 to 8, fused into a monadelphous tube. Pistil 4-, rarely 3-carpellate, and as many-celled. Ovules many, minute, elongate; style short or absent; stigma 4-lobed, lobes often grooved. Fruit a brown, lanceolate to oval capsule, dehiscing loculicidally. Seeds 5 to 35 mm, numerous, light, testa greatly elongate at both ends, embryo minute in axis of albumen.

Distribution.—Madagascar and Seychelle Islands to India, southern China, Malay Peninsula and Archipelago, and northeastern Australia.

Key to the Philippine species of Nepenthes.

a^1. Lid of pitcher without internal keel or processes.
  b^1. Leaves sessile, longitudinal veins of lamina 2 to 4 pairs.
    c^1. Nerves of laminæ 2 to 3 pairs, pedicels 1-flowered.. **N. blancoi Blume.**
    c^2. Nerves of laminæ 4 pairs, pedicels 2- to 3-flowered **N. philippinensis Macfarlane.**
  b^2. Leaves petiolate. longitudinal veins of lamina 2 to 4 pairs. Nerves of laminæ 3 pairs, pedicels 2- to 1-flowered.... **N. copelandii Merrill.**
  b^3. Leaves sessile, longitudinal veins 5 to 6 pairs.
    c^1. Pitchers large oval, with oblique orifice. **N. merrilliana Macfarlane.**
    c^2. Pitchers ventricose below, constricted in middle and with transverse orifice..... **N. ventricosa Blanco.**
    c^3. Pitchers ventricose below, constricted in middle and with oblique orifice ..... **N. burkei Masters.**
    c^4. Pitchers obconic, orifice with elongated neck. **N. deaniana Macfarlane.**
  b^4. Leaves petiolate, longitudinal veins 7 to 10 pairs. Leaf margin ciliate, pitchers cylindric..... **N. phyllamphora Willdenow.**

a^2. Lid of pitcher with internal keel or processes.
b^1. Leaves lanceolate, with 3 to 4 pairs of veins..... **N. alata Blanco.**
b^2. Leaves truncate, with 5 to 6 pairs of veins.. **N. truncata Macfarlane.**

NEPENTHES BLANCOI Blume.

Nepenthes blancoi BLUME, Mus. Bot. Lugd. Bat. 2 (1852) 10; MACFARLANE in Pflanzenreich 36 (1908) 40.

Plant short, erect or low climbing. Stem 3 to 6 dm, trigonous, puberulous to glabrous. Leaves 15 to 25 × 1.5 to 2.5 cm subpetiolate, one-half to one-third amplexicaul, linear-lanceolate, longitudinal veins 2 to 3 pairs united by irregular transverse or oblique veins, tendril slender, gradually thickened into recurved base of pitcher; pitchers 10 to 18 cm long, monomorphic to subdimorphic, reddish green, lower ventricose below, cylindric above, with continuous ciliate anterior wings, upper almost cylindric with shallow ciliate wings prolonged into ridges above, mouth oblique, peristome cylindric, uniform, narrow, serrulate along inner margin, lid ovate-cordate, submembranous, red spotted without, and with many small marginal, also few large median glands, pitcher within glaucous purple and conducting over upper half, glandular with many immersed discrete glands over lower. Inflorescence 40 to 60 cm long of which peduncle 30 to 40 cm. Sepals 4, tomentose without, glandular over upper half within; staminal column hairy, anthers biseriate with 12 below, 4 above; ovary shortly stalked pubescent; capsule 15 to 17 cm, puberulous.

This species has a rather uncertain history. In 1837 Blanco described and named *N. alata* and *N. ventricosa.* He then referred vaguely to two other forms, one from Agoo,[2] Pangasinan Province, Luzon, and another from Cebu Island, but he named neither. In 1852 Blume described as "species non satis cognitae" both *N. alata* and *N. ventricosa,* but further he briefly described, as *N. blancoi,* a form with narrower leaves than in either of the above, with elongate narrow pitchers bialate in front, and with a simple raceme. To this he gave the same native names as did Blanco for his Cebu specimen, *sulud sulud, sogon sogon;* but there is no evidence that Blume had a definite plant before him. Hooker, therefore, rejected *N. blancoi* as "non satis notæ." In the "Novissima Appendix" to the third edition of Blanco's Flora de Filipinas (1880) 173 *N. blancoi* is not mentioned.

Relying on the three characters given by Blume, I have described fully a form that was gathered by Merrill on Culion

[2] The Agoo plant, mentioned by Blanco, is undoubtedly a form of *Nepenthes alata* Blanco.—E. D. MERRILL.

Island in 1902, and which has since been gathered by R. C. McGregor on Marilison Island, Antique Province, Panay, in 1918. The very narrow leaves, narrowest of all the Philippine species, the elongate narrow pitchers, and the simple raceme are leading characters; but there is as yet no exact evidence that the form occurs in Cebu Island, though such would be in eastward line with its occurrence in Culion and Marilison Island.

Therefore, I would accept, as a typical specimen, *Merrill 516* from Culion, as that which agrees with Blume's description of *N. blancoi,* and *Bur. Sci. 32313 McGregor,* Marilison Island. This species grows on open grassy slopes at low altitudes, frequently occurring at or near sea level.

NEPENTHES PHILIPPINENSIS Macfarlane.

Nepenthes philippinensis MACFARLANE in Pflanzenreich 36 (1908) 43.
Nepenthes brachycarpa MERRILL in Philip. Journ. Sci. 10 (1915) Bot. 306.

Plant short climbing. Stem 6 to 10 m, cylindric, glabrous, lower internodes short, upper 1.5 to 2 cm. Leaves 15 to 25×2.5 to 5 cm, sessile, leathery, lanceolate one-half to two-thirds amplexicaul, gradually attenuate into the tendril, glabrous, longitudinal veins 4 pairs united by obliquely ascending transverse veins; tendril 15 to 20 cm long, thickened toward pitcher base; pitcher 8 to 12 × 2 to 3.5 cm, subdimorphic, lower ventricose tubular, upper almost tubular, reddish green below to red above, when young ferruginous pubescent, at length subglabrous, mouth obliquely ovate, slightly elevated behind, peristome cylindric, finely striate and on the inner margin finely toothed, lid 2 to 2.5 cm, ovate-cordate, greenish red to red within with few large median perithecioid glands and many small marginal ones, pitcher within in the upper half glaucous purple and detentive, below shining and with small deeply sunk discrete glands. Staminate inflorescence 45 to 55 cm long, of which the peduncle is 20 to 25 cm, when young ferruginous-pubescent, at length glabrous below; raceme narrow, elongate, densely flowered, pedicels 8 to 10 mm long, 2- to 3-flowered below, pedicels and outer sepaline surface ferruginous-tomentose; sepals 4 in 2 unequal pairs, outer oval, inner elliptic, both yellow and covered within by abundant small nectar glands. Staminal column below and the inner sepaline base hairy, anthers 8, uniseriate. Pistillate inflorescence 30 to 50 cm long of which the peduncle is 20 to 35 cm, pedicels uniflorous, the lowest 2 or 3 flowers bracteolate, outer sepaline surface and ovary densely ferruginous-puberulous,

ovary ovate, 4-sulcate, stigma 4-lobed. Capsule 1 cm long, shining, light brown; seeds 3 to 4 mm long, shortly caudate.

This species is known as yet only by the following specimens. One is a staminate shoot with mature leaves collected on Mount Victoria in Palawan Island, March 24, 1906, *Foxworthy 721*, at an elevation of 350 m. Another is a two-year-old plant, with crowded leaves and fairly mature pitchers, that was collected by Curran on Mount Pulgar, Palawan, at 1,300 m, *No. 3896*. Pistillate and fruiting specimens are represented by *No. 9588* and *No. 9615* collected by Merrill, on "dry steep rocky slopes of forest ridges" at 250 to 400 m elevation, at Silanga in Palawan, May, 1913, and described by him as *N. brachycarpa*.

NEPENTHES COPELANDII Merrill.

Nepenthes copelandii Merrill ex MACFARLANE in Pflanzenreich 36 (1908) 60.

Stem 1 m high, cylindric, glabrous or sparsely puberulous. Leaves 10 to 15 × 2 to 3.5 cm, shortly petiolate, one-third to one-half amplexicaul, winged, lamina elliptic, glabrous or slightly pubescent at the base, longitudinal veins 3; pitchers 10 to 15 × 3 to 3.5 cm, lower cornucopioid, upper cylindric, tomentose without beneath the peristome, green or purple flushed or spotted, wings reduced to 2 strong anterior nerves, peristome cylindric, narrow in front, somewhat widened behind and convergent below the insertion of the lid, mouth oblique, slightly elongated into a neck behind, lid 3 to 4 cm long, cordate-orbicular, purple spotted within, with a thickened median ridge and many circular glands. Pitcher within to one-third its depth glaucous purple, below shining and with many discrete oval glands. Inflorescence 20 to 35 cm long, the peduncular part thrice as long as raceme, pubescent, at length glabrous, pedicels mostly biflorous. Sepals 4, without and along the inner margin densely tomentose, within densely glandular. Staminate column equal to sepals, pubescent below, glabrous above, anthers 8 to 10, uniseriate. Ovary ovate, brown, pubescent. Capsule 15 to 20 mm long, brown, seeds 8 to 10 mm long, delicate, yellow.

MINDANAO, Davao district, Mount Apo, *DeVore and Hoover 294*, May, 1903, *Copeland 1033*, April, 1904, *Elmer 11523;* Mount Matutum, *Copeland*, April, 1917. CAMIGUIN DE MISAMIS, *Bur. Sci. 14496, 14650 Ramos*, March, 1912.

This species, so far as known, is confined to Mindanao and the neighboring island Camiguin, and is reported to grow among shrubs at an elevation of 2,500 to 3,000 m on Mount Apo. It occurs at lower altitudes on Camiguin Island.

NEPENTHES MERRILLIANA Macfarlane.

Nepenthes merrilliana MACFARLANE in Bot. Contrib. Univ. Penn. 3 (1911) 207.

Nepenthes surigaonensis ELMER, Leafl. Philip. Bot 8 (1915) 2785.

Plant terrestrial or largely epiphytic. Stem 8 to 12 mm thick, subcylindric when young, becoming trigonous when mature, glabrous, internodes short, the leaves aggregate on stem below, 2 to 4 cm apart on elongate ascending shoots. Leaves 20 to 50 × 4 to 7 cm, oblanceolate, sessile, three-quarters amplexicaul and tapering decurrent to next node below, gradually widening upward toward the slightly cordate apex, glabrous or minutely punctate beneath, longitudinal veins 6 or 7, all starting from the amplexicaul leaf base, transverse veins parallel, obliquely radiating and ascending; tendril 25 to 60 cm long, gradually thickened toward the recurved pitcher base; pitcher 15 to 30 × 6 to 14 cm, softly ferruginous-tomentose when young, at length glabrous, ovate to oval in outline, purple-green with deep purple blotches, veins prominent, obliquely ascending and united by wavy cross veins, wings continuous from near the base to the peristome, 8 to 15 cm wide, long ciliate and expanded upward in front of peristome, mouth ovate, oblique, peristome 1.5 to 3.5 cm wide, strongly striate, outer margin spreading, reflexed, undulate, inner inflexed, sharply denticulate along the edge; lid 6 to 14 × 5 to 12 cm, ovate, coriaceous, without ferruginous-puberulous and punctate, within shining and dotted by minute orifices of deeply sunken honey glands, spur 1 to 2 cm, puberulous, pitcher interior shining, green, with many irregular purple spots, densely covered with small, nearly uniform immersed glands. Inflorescence 40 to 50 cm long, of which the peduncle is 10 to 15 cm, lax-flowered, pedicels spreading, biflorous. Sepals 4, oval, externally like the pedicels brown puberulous, within purple with many minute nectar glands. Staminal column glabrous, longer than the sepals, anthers 8, uniseriate. Ovary ovoid, shortly stipitate, densely ferruginous-puberulous, stigma 4-lobed, purple.

MINDANAO, Surigao Province, *For. Bur. 7545 Hutchinson,* May, 1907, *Bur. Sci. 34501, 34503 Ramos and Pascasio,* May, 1919: Agusan Province, *Elmer 13705,*[3] type of *Nepenthes surigaonensis* Elm. DINAGAT, *Lyon 6,* February, 1909, "Oroc" *Loher 5209* in Herb. Keib (probably this was brought to Mr. Loher from Mindanao).

[3] This is erroneously cited in the original description as No. 12705.—E. D. MERRILL.

Elmer's type of *Nepenthes surigaonensis* differs in no way from *N. merrilliana* except that the pitchers are rather small, 15 × 8 to 10 cm., and are more strongly and persistently ferruginous-hirsute than the typical material from lower altitudes. The veins of the lamina in it are 6, not 4, as described by him, while the microscopic structure of the lid glands and of the interior pitcher glands exactly agrees with *N. merrilliana.* Elmer has, however, improved on my original description, which was taken from an immature and lower shoot. He shows that, while the stem is almost cylindric in the soft young shoots, it becomes sharply trigonous on elongate shoots when full-grown. Such shoots also have decurrent petiolar wings that extend downward through an internode. It remains to be determined whether connecting examples occur between the type of the lowlands and Elmer's hirsute upland form that was gathered at 5,750 feet elevation.

The above, with *N. truncata* (both peculiar to the Philippines) and *N. rajah, N. decurrens,* and *N. maxima,* surpass all others in size and in the striking aspect of the pitchers.

NEPENTHES VENTRICOSA Blanco.

Nepenthes ventricosa BLANCO, Fl. Filip. (1837) 807, ed. 2 (1845) 556, ed. 3, 3 (1879) 215; MASTERS in Gard. Chron. III 30 (1901) 312, with illustrations.

Plant terrestrial or epiphytic, bright green. Stem to 2 m high, cylindric to trigonous, glabrous, internodes short below, 1 to 2 cm long above. Leaves 15 to 25 × 2 to 3 cm, thick, herbaceous, sessile, obscure; tendril 10 to 20 cm long, slender, gradually expanded into the recurved base of the pitcher; lower pitchers cylindric-ventricose, upper strongly ventricose below, constricted in middle, expanded into the elliptic and transversely placed mouth, above pale green often flushed with red, anterior wings reduced to nerves, peristome 10 to 25 mm wide, green to red, outer margin reflexed and undulate, inner with small teeth, lid 4 to 5 × 2 to 3 cm, small compared with size of mouth, ovate-cordate, green to greenish red, traversed by 3 to 4 pairs of veins, pitcher within shining, copiously glandular, glands minute, immersed above, discrete and exposed below. Inflorescence 25 to 60 cm, staminate longer than pistillate, ferruginous-puberulous, pedicels slender 1-flowered, aggregate and unilateral in fruit. Sepals elliptic-obovate, within with 15 to 25 glands. Staminal column puberulous below, glabrous above, anthers 8. Ovary shortly stalked. Capsule 17 to 25 mm, lanceolate, stipitate.

Seeds 12 to 15 mm long, yellowish, testa, warted around the embryo.

LUZON, Ilocos Norte Province, Ifugao and Benguet Subprovinces, and Nueva Vizcaya, Bataan, Rizal, Tayabas, Camarines, and Sorsogon Provinces. Representative specimens are *Bur. Sci. 9389 Robinson, 26520 Ramos and Edaño,* and *23505, 33283 Ramos.*

The above species is very near to *Nepenthes burkei.* So far as specimens at present inform us, it would seem that *N. ventricosa* is confined to Luzon, although rather widely distributed there, while *N. burkei* is restricted to Mindoro and Panay, and may be a geographical variety of Blanco's species.

NEPENTHES BURKEI Masters.

Nepenthes burkei MASTERS in Gard. Chron. III 6 (1889) 492, fig. 69.

Similar to *N. ventricosa* except that pitchers are less ventricose, color green to reddish green with purple spots below, purple and green blotched above, mouth oblique, ovate in outline, lid 5 to 8 × 3 to 5 cm, pale green with purple and red spots, traversed by 6 to 7 pairs of veins. Pedicels radiately disposed around rachis in flower and fruit. Capsule slightly stipitate. Seeds 9 to 11 mm, reddish brown, not or very slightly warted around embryo.

Without locality, *Burke.* MINDANAO, Mount Halcon, *Whitehead, Merrill 5774, For. Bur. 4392 Merritt.* PANAY, Mount Midiaas, *Bur. Sci. 30680 Ramos and Edaño, 32597 McGregor, 35686 Martelino and Edaño.*

NEPENTHES DEANIANA Macfarlane.

Nepenthes deaniana MACFARLANE in Pflanzenreich 36 (1908) 57.

Plants so far as known low, spreading by shoots, or shortly ascending. Stem 20 to 30 cm high, 4 to 5 mm thick, glabrous, closely surrounded by sessile leaf bases. Leaves 6 to 12 × 3.5 to 4 cm, lanceolate or obovate, sessile, one-half to two-thirds amplexicaul, glabrous, when young ferruginous-tomentose along the midrib beneath; longitudinal veins 4 to 5 pairs, obscure, united by irregularly reticulate transverse veins, tendril 10 to 15 cm long, delicate, ferruginous-hirsute when young, at length puberulous; pitchers 6 to 9 × 2.3 to 3.5 cm, obconic, membranous-herbaceous, ferruginous-hirsute when young, at length glabrous, brown tomentose below the rim, veins distinct, united by reticulate transverse veins, wings continuous from near the base to the peristome, expanded, long ciliate. Mouth transverse or slightly oblique, prolonged behind into a neck 1 to 1.5 cm high.

Peristome 5 to 8 mm wide, finely striate, cylindric with sharply recurved outer and inflexed inner margin that bears long attenuate teeth, lid broadly cordate, traversed by 8 to 9 pairs of delicate reticulate veins, without when young brown pubescent, within abundantly covered by small circular glands, pitcher interior glaucous purple over posterior triangular neck, from thence downward shining and covered with small, discrete, deeply sunken glands. Staminate inflorescence (alone known) 15 to 20 cm long, pubescent to glabrous. Pedicels compressed and expanded at base, 1-flowered, bracteolate near the lower third. Sepals 4, in unequal pairs, broadly oval and elongate, within with many small glands. Staminal column glabrous, equal to the sepals, anthers 8, uniseriate.

PALAWAN, very common on the summit of Mount Pulgar, at an elevation of 1,300 m, *For. Bur. 3891 Curran;* Cabatuan River, *For. Bur. 2337 Danao.*

As yet only two collections have been made of the above distinct species. Both specimens are evidently side branches or spurs produced by a main shoot. Whether the species is of low dwarf habit, or is an elongated climber, as is suggested by the coils on the tendrils and from a pencil note of the latter collector, can only be determined by future field observation.

NEPENTHES PHYLLAMPHORA Willdenow.

Nepenthes phyllamphora WILLDENOW, Sp. Plant. 4 [2] (1805) 874.

Plant elongate, branching, bright green. Stem 5 to 8 m long, 7 to 11 mm thick, cylindric, stellate-pubescent, at length glabrous, internodes short to 8 to 10 cm long. Leaves 15 to 45 × 5 to 8 cm, herbaceous, petiolate, one-half amplexicaul, sessile or slightly decurrent, elliptic-lanceolate, margin finely ciliate, longitudinal veins 7 to 8, evident and united by many fine parallel ascending veins; tendril slender, slightly thickened toward the recurved base of the pitcher; pitcher 8 to 15 × 2 to 3 cm, cylindric above, tubular-ventricose below, pale green to crimson-green, wings on lower pitchers narrow, ciliate, on the upper ones reduced to strong veins, mouth transverse or slightly oblique, circular or transversely elliptic in outline. Peristome 4 to 7 mm wide, uniform or slightly widened in front, green to crimson, lid 2 to 4 cm long, orbicular, within covered by abundant circular glands, pitcher within to half its depth glaucous or purple-green, smooth and conducting, shining in lower half and with many discrete sunken glands. Inflorescence 20 to 45 cm long, stellate-pubescent, at length glabrous, pedicels 2- to 1-flowered

below, 1-flowered above, sepals elliptic-ovate, pubescent without, densely and richly glandular within. Staminal column glabrous, with 16 to 20 biseriate anthers. Ovary ovoid, white tomentose. Capsule 18 to 26 mm long, brown, shining. Seeds 15 to 18 mm long, filiform.

This widely distributed species was previously reported in the Philippines by Vidal (*No. 3524*) from Surigao in Mindanao Island. It is now well represented by specimens collected by Mary S. Clemens at Camp Keithley, Lake Lanao, Mindanao, in 1907. These are the strongest specimens yet studied by me from any locality, and bear exceptionally large fruiting inflorescences.

NEPENTHES ALATA Blanco.

Nepenthes alata BLANCO, Flora Filip. ed. 1 (1837) 805; ed. 2 (1845); ed. 3, 3 (1879) 214; HOOK. f. in DC. Prod. 17 (1873) 99; MACFARLANE in Pflanzenreich 36 (1908) 71.

Plant terrestrial or epiphytic, climbing. Stem 1 to 3 m high, obtusely trigonous, when young hairy, at length glabrous. Leaves 10 to 30 × 2.5 to 5 cm, petiolate, petiole one-third to one-half amplexicaul, winged, gradually expanded upward into the lamina; lamina lanceolate to elliptic, fuscous or ferruginous-pubescent when young, at length subglabrous, longitudinal nerves 3, rarely 4 pairs, tendril 12 to 25 cm long, slender below, gradually thickening toward the recurved base of the pitcher. Pitcher 10 to 20 × 2 to 5 cm, the lower cylindric-ventricose, upper cylindric, pubescent when young, wings forming prominent nerves below widening upward into ciliate laminæ, mouth oblique, ovate, prolonged posteriorly into a triangular neck, peristome uniform or posteriorly widened and undulate in outer margin, lid semimembranous, ovate-cordate, within with a basal prominent keel and many small circular nectar glands; pitcher interior to one-half or two-thirds depth glaucous purple, smooth and "conducting," below shining and with many discrete exposed glands, inflorescence 25 to 70 cm long, staminate longer than pistillate, axes gray or ferruginous-hairy, bearing 1-flowered hairy pedicels. Sepals tomentose without, purple and finely glandular within. Staminal column hairy, at length glabrous, anthers 8 to 10, uni- or subbiseriate. Pistil white to ferruginous-tomentose. Fruit 20 to 40 mm long, shining. Seeds 12 to 20 mm long.

The following are additions to previously recorded localities: LUZON, Ilocos Norte Province, *Bur. Sci. 26726 Fenix:* Bontoc Subprovince, Bauco, *Vanoverbergh 53:* Lepanto Subprovince,

Cervantes, *Bona 17:* Benguet Subprovince, Pauai to Kabayan, *Bur. Sci. 8796 McGregor;* Pauai, *Bur. Sci. 31877 Santos:* Bataan Province, Mount Mariveles, *Merrill 5181:* Laguna Province, Mount Maquiling, *Baker 399, 2780, Holman 17, For. Bur. 15379 Tamesis, Gates 5395, Sulit 507;* San Antonio, *Bur. Sci. 14963 Ramos:* Tayabas Province, *For. Bur. 13091 Curran:* Mount Cadig, *Bur. Sci. 20845 Escritor, For. Bur. 21157 Miranda:* Guinatucan, *Bur. Sci. 13185 Foxworthy and Ramos:* Sorsogon Province, Irosin, *Elmer 15874.* PANAY, Mount Bulilao, *Bur. Sci. 35664, 35665 Martelino and Edaño.* Leyte, *Wenzel 681.* CAMIGUIN DE MISAMIS, *Bur. Sci. 14650 Ramos.*

This is the most abundant indigenous species of the Philippine Islands and extends from the low country to 2,400 m on Mount Apo. I have recorded the two following varieties:

NEPENTHES ALATA var. BIFLORA Macfarlane.

Glands of lid small, abundant over middle part and keel, few large and scattered toward margin. Pedicels 2-, rarely 1-flowered.

NEGROS, Mount Silay, *Whitford 1537.*

NEPENTHES ALATA Blanco var. ECRISTATA Macfarlane.

Keel of lid shallow or absent, lid glands few, large, widely scattered along the median part.

MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4632 Mearns and Hutchinson:* Agusan Province, Mount Urdaneta, *Elmer 14248.*

Nepenthes graciflora Elm. Leafl. Philip. Bot. 4 (1912) 1494, *Elmer 12465, 17766, 18837* from Sibuyan and from Mount Maquiling, Laguna Province, Luzon, is *Nepenthes alata* Blanco or its variety *ecristata* Macfarlane.

NEPENTHES TRUNCATA Macfarlane.

Nepenthes truncata MACFARLANE in Bot. Contrib. Univ. Penn. 3 (1911) 209, *t. 11.*

Plant terrestrial or epiphytic. Stem stout, upright, cylindric, 15 to 20 mm thick, above closely encircled by leaves and softly ferruginous-tomentose. Leaves in seedlings densely rosulate, shortly petiolate, gradually expanded upward into the lamina, which is deeply obcordate to truncate-obcordate, margin crenate-ciliate toward apex; entire surface as well as tendril and pitcher hirsute, especially along midrib; tendril 5 to 10 mm long, rather abruptly expanded into the cylindric-ventricose pitcher, wings

broad, continuous from pitcher base to peristome and ciliate along their margins, lid ovate, externally diffusely ciliate, pitcher within cylindric with conducting surface one-third to one-half its depth, lower half to third ventricose and sparsely covered with digestive glands. Mature leaves 10 to 45 × 9 to 24 cm, subcoriaceous, petiolate; petiole 3 to 30 × 0.5 to 2.5 cm, winged, wings below vertically dilated, narrowed upward into shallow ridges, when young tomentose and sparsely hirsute below along the sides of the midrib, at length glabrous, base of lamina cordate, apex cordate-truncate to abruptly truncate, margin undulate, upper surface glabrous, lower finely pubescent to punctate, midrib deeply grooved above, prominent, pubescent and hirsute beneath, longitudinal veins disposed in 5, more rarely 6 pairs, innermost arising above base of lamina and gradually diverging upward, abruptly curving near the apex and converging toward midrib, remaining pairs arising near laminar base and running parallel to the first, innermost pair in large leaves 64 to 70 mm, second 85 mm, third 100 mm, fourth 110 mm, fifth 115 mm, removed from midrib, transverse nerves abundant, parallel and abruptly diverging from midrib, tendril 15 to 50 cm long, nearly uniform, hirsute-tomentose and abruptly enlarging into the base of the pitcher; pitcher 15 to 35 × 4 to 10 cm, cylindric or slightly ventricose below, softly ferruginous-tomentose when young, at length glabrous, wings 1 to 2 cm apart, expanded and ciliate on young pitchers, in old pitchers reduced to prominent nerves, mouth oblique to nearly transverse, peristome 3 to 6 cm wide, outer margin broadly expanded, undulate, sharply ridged, inner inclined with margin finely denticulate, behind with margins apposed and elevated into a triangular neck beneath the lid, lid 5 to 11 × 3 to 9 cm, broadly cordate, traversed by 6 to 8 pairs of veins, outside pubescent to glabrous, within densely covered by small to large subperithecioid attractive glands and enlarged at base into a prominent, median, richly glandular keel, calcar 10 to 30 mm long, densely ferruginous-villous together with the base of the lid, pitcher within over posterior triangular neck glaucous purple and "conducting," from mouth downward, shining, glandular and detentive, detentive glands above discrete and sunk in pockets, below closely packed, transversely oval and exposed. Inflorescence (staminate) 80 to 125 cm long, of which peduncle is 25 to 45 cm, axis tomentose. Pedicels 30 to 40 mm long, laxiflorous and biflorous, rarely triflorous, common pedicel one-fourth to one-fifth the length of the

separate pedicels. Sepals 4, broadly oval to circular, without and along inner margin finely puberulous, within densely covered by nectar glands. Staminate column 7 to 8 mm long, tomentose at base, glabrous above, anther mass subglobose, anthers 10 to 12, sinuous, subbiseriate. Pistillate pedicels bitriflorous, along with exterior surface of sepals and ovary densely puberulous, stigmas 4, deeply bilobed. Inflorescence up to 85 cm long, of which the peduncle is up to 60 cm. Capsule lanceolate, 35 to 40 mm long, villous to puberulous. Seeds 12 to 15 mm long, corrugate around the embryo.

This unique species was first described and figured by me in 1911 from a small and a large leaf, forwarded to me by Mr. Merrill. More recently Mr. Merrill sent additional material that consisted of a fairly large leaf and fruits collected by F. T. Eddingfield, also a similar leaf attached to a short piece of stem bearing a staminate axis, and accompanied by two seedling plants. Still later he supplied some fine flowering shoots, and from all of these the above description has been prepared.

The history of our knowledge of the species to date is as follows:

A herbarium specimen, *No. 270,* collected on March 18, 1906, by F. H. Bolster at Cansuran, Surigao Province, Mindanao, "on bare open soil of old placer mine," altitude 750 feet, height of plant 1 foot. It was a young leaf belonging to what was probably a two-year-old plant.

A second specimen, *No. 171,* was collected on July 28, 1907, by W. B. Allen at Samsolang in Surigao, "on open mountain side," altitude 600 m. This was a large and striking leaf that served for description and illustration by me, and is the type specimen in the Manila Herbarium that was figured by me.

More recently Mr. Merrill forwarded two additional sheets, collected on March 22, 1911, by C. M. Weber on the west slope of Mount Hilong-hilong, Agusan Province, Mindanao. It grew on an exposed rock cliff, common on the hillside among tall coarse grasses. Flower yellowish, green edges tinged with purple. The specimen shows a stout stem bearing one large typical pitchered leaf, and from opposite the petiole of the next leaf a long staminate inflorescence springs. Included on the sheet was a small packet with two seedlings, each bearing truncate or deeply obcordate leaves that looked very different from the seedling leaves of other species previously studied. These were all collected at 335 m elevation.

The other sheet, without field number, was obtained in April, 1912, by F. T. Eddingfield, and on the herbarium slip Merrill records:

> fresh specimen brought in by Mr. Eddingfield of the Divison of Mines, Bureau of Science. Growing on open steep rocky slopes and in trees, overhanging streams in a very wet region. The specimens came from exactly the same locality as the original one collected by Allen. Originally discovered by an American miner, who showed them to Mr. Allen and afterwards to Mr. Eddingfield.

Fruits accompanied this specimen.

Sheet *No. 13483* was distributed by A. D. E. Elmer and is inscribed: *N. truncata* Macf., Cabadbaran (Mt. Urdaneta) Province of Agusan, Island of Mindanao, August, 1912. It is a staminate shoot.

Sheets *Nos. 34540* and *34541* are from Surigao, and were collected April, 1919, by M. Ramos and J. Pascasio "on ridges, altitude 680 to 750 m, scarcely climbing, but spreads over the ground."

The nearest species to it is *N. veitchii* of Borneo, which agrees with this in having alternate spreading leaves that can expand in distichous fashion on the ground or climb along fallen tree trunks, on either side of which the leaves with their liquid-bearing pitchers can depend.

Nepenthes gracilis Korthals has been recorded from the Philippines by F.-Villar,[4] but its occurrence in the Archipelago is very doubtful. A sterile specimen accompanying *Bur. Sci. 34501, Nepenthes merrilliana* Macfarlane, may represent Korthals's species, but more complete material is necessary to determine its exact identity. The species is widely distributed in the Malay Peninsula, Sumatra, and Borneo.

[4] Novis. App. (1880) 173.

NOMENCLATURE OF THE ABACÁ PLANT

By E. B. Copeland

Of Chico, California

The names which various authors have attempted to give to the source or sources of abacá fiber, since 1753, the earliest date of valid specific names, are as follows:

Musa textilis Née, 1801.
Musa sylvestris Colla, 1820.
Musa abaca Perrottet, 1825.
Musa Troglodytarum Textoria Blanco, 1837.
Musa mindanensis "Rumph" Miquel, 1855.

Not one of these names was accompanied by a diagnosis sufficient to distinguish the plant from all of the related species or forms of whatever rank, for the very sufficient reasons that not one of the authors except Blanco had a plant in hand or very definitely in mind; none gives a definite type locality; and even the discussions which accompany some of the names are not based chiefly on the authors' own observations. Nevertheless, in view of the dominant economic importance of abacá in the Philippines, of the historic interest of some of these discussions, and of the fact that the books containing some of these discussions are very rare, it has seemed worth while to translate and assemble the various "descriptions" and comments. As *Musa silvestris* and *M. mindanensis* are based on names and descriptions given by Rumphius, his account is included with the others. When taking up this work, I naturally expected to examine living or preserved material of a considerable number of the abacá-producing plants; but, after waiting more than a year to receive material which some of my friends were good enough to collect, I feel forced to abandon this hope.

The translations follow, with such notes as may be instructive.

ABACA, WHICH IS MUSA TEXTILIS[1]

By Don Luis Née

Necessity has at all times awakened the industry of men. Content at first with what was strictly necessary, they sought food and shelter in

[1](From "Anales de ciencias naturales, mes de julio de 1801, Nom. c 11. Tomo quarto, pp. 123–130.) A translation was published in the Annals of Botany by Koenig and Sims, soon after the Spanish publication.

the products of nature; and desiring afterward more comfort or luxury, they improved their customs and crude products. Progress was slow and almost imperceptible, while the tribes or families were of few individuals; but as the number of consumers increased, new means of subsistence were sought out. The unfortunate people of Patagonia, in spite of the rigor of the climate, content themselves to-day with the pelts of sea-wolves to cover their backs, and feed on vegetables and the product of fishing and the chase. In New Zealand and New Wales, our kind is still found brutish and without desire to advance. It is better in the islands of the Pacific Ocean, where certain hierarchies and order are found, some conveniences and various artefacts which give evidence of talent and effort. They cultivate with care the vegetables which yield them food, and those the fibers of which can serve to produce the cloths which they afterward color in various ways.

Such were the peoples of the Philippines before the Spaniards arrived there. Their own soil sustained them with little work; and the vegetation furnished them materials which they reduced to clothes to cover and adorn their bodies; but with the arrival of our colonies, the consumption increased, commerce became easy, industry grew, and the arts which were in their infancy were in some measure perfected. I saw with pleasure the occupation of the natives; but was astonished at the little profit of their works, in comparison with those of Europe. In Nabuá, they used about a month in making a hat which is hardly worth three dollars; and a woman spends seven days in preparing and weaving a piece of abacá worth three reales.[3] Altogether, the last-mentioned branch of industry is so general, and so great are the utilities which accrue to the Provinces of Albay, Laguna, and Camarines, that it seems to me worth while to describe the plant which produces the raw material and the manner of utilizing it up to the production of cloth and cordage. For the clearing up of my studies, I owe a great deal to the zeal and learning of the most Illustrious Bishop of Nueva Caceres, D. Domingo Collantes, to whom I give public testimonial of my gratitude for the notes he has kindly furnished me, and which I am making use of in this paper.

In the Philippines, they call the fibers for the production of cordage and cloth, and likewise the plant which yields these fibers, abacá.[3] This is a particular kind of plantain and the same one which Rumphius called in Latin *Musa sylvestris*, and in the native tongue pissang-utan.[4] It is certain that it grows wild in the Philippines and Mindanao; but it is

[2] The real is like the American "shilling" or "bit," one-eighth of a peso or dollar. In Nee's text are mentioned "reales de Vellon," and reales of money worth two and one-half of vellon. The vellon was a copper piece worth five cents, two and one-half being worth one-eighth of a dollar. In some localities in the Philippines, the word survives as "billion," but is applied to the "peseta," twenty centavos.—E. B. C.

[3] The natives distinguish many varieties of abacá, such as:

Stout abacá, or abacá brave, which the Bicols call *agotai.*

Mountain abacá, the fibers of which serve only for cords, which in Bicol are called *agotag,* or *amoquid.*

The *sagig* of the Visayans.

The laquis of the Visayans. They called the fiber of abacá *lanot.*

[4] Herb. Amboinense Vol. 5, page 139.

equally so that no other species or variety of this genus is cultivated with such care as this one, because of the great use which the natives have been able to make of it. There are extensive plantations in the Island of Luzon and in the Provinces of Albay, Laguna, and Camarines, but especially in the neighborhood of Mount Mayon,[5] the base of which is some 15 leagues in circumference. In this spacious region and in the immediate neighborhood of another great mountain, called Isarog, is found a soil suitable for this plant, which prospers only in moist localities that are shady and with rich soil. In those places, thick groves are formed by the multitude of trunks and suckers, protected from the sun by the large and beautiful leaves which crown the trunks. These rise from a sort of bulb clothed with fibers and grow in less than eighteen months, without ever branching, up to 7 feet in height, being then as thick as the thigh. In the middle is a white smooth pith like a wax candle as big as the arm, covered with a multitude of fibrous coats placed one over the other, which were the sheaths of the former leaves. The leaves, ten to twelve in number, from the crown, some horizontal, and those of the middle erect or somewhat inclined; they are 5 feet or more in length and 1.5 in width, borne on petioles about a foot long. The latter are prolonged on the back, forming the projecting midrib, from which numerous little veins run out. From the center of the crown of leaves, and when this herbaceous plant reaches maturity (less than two years), there is born a thick peduncle covered with concave, ovate, acute, partial spathes, which develop and open as the peduncle elongates up to 3 or 4 feet in length; and then the flowers appear, nine to fourteen in each spathe, and are fertilized, resulting in time in the fruits, which are hard and green, 1.5 to 2 inches long, insipid, and entirely useless.

When the plant reaches the stage of fruiting, it appears like an herb; but it is reproduced by suckers, little and big. In this case, its trunk remains useless; and, for this reason, there are very few which succeed in flowering, because the natives cut them when they are one and a half years old, this being the proper age for harvesting the trunk. They cut it at the root and at the top where it joins the leaves, and it usually remains about 5 feet long, and they open it length-wise to separate the pith from the sheaths. Of the latter, the outside are hard and strong, and produce the *bandalá,*[6] intended for cordage. The interior ones, being finer and smoother, yield the *lupís*[6] for the weaving of *nipis*[7] and other excellent cloths; and from the intermediate one is extracted the *tupóz,*[6] which is intended for *guinarras.*[8]

The sheaths are found embedded in a thick matrix of but little consistency and, to separate them from this material, they are first reduced

[5] The Bishop of Nueva Caceres, already mentioned, gave me a description of the volcano of Albay which is in Mount Mayagong; and of Mount Isarog in Camarines Province.

[6] Bandalá, lupís, and tupóz are still used in the same sense, only the first, however, being in common use throughout the Bicol region.—E. B. C.

[7] This root means thin; as applied here, it means thin cloth.—E. B. C.

[8] Guinarras is the Bicol equivalent of the Tagalog sinamay, meaning either fairly fine cloth made largely or wholly of abacá, or a piece of such cloth. The word has also other meanings.—E. B. C.

to bands 1.5 or 2 inches wide, which are passed through a sort of flaxbrake, the beam of which, armed with three broad knives,[9] is held fast with the right hand while the bands or strips are drawn through with the left hand and, coming out free of the pulp, are reduced to fibers. These are afterward dried in the sun, gathered, and assigned to various uses according as they are more or less fine. Those which are to serve for cordage, rope, and string receive no other treatment; but the others are softened with a mallet,[10] and the single fibers, being afterward separated, are tied with almost invisible knots and formed into skeins, and wraped for the manufacture of cloths.

The pieces of sinamay are 4 yards in length and a half yard wide,[11] and of various qualities and prices; the lowest is worth a real of the local money which is worth two and a half vellon.[2] But there are cloths so fine that they sell at 5 dollars, and from these shirts with cuffs are made.

The woven cloths are placed in lime water for a period of twenty-four hours. They are taken out of this and washed in clear water. They are then allowed to dry, and then placed in rice water for twenty-four hours, after passing through which, they are washed again in clear water, and become lustrous, smooth, and white. The natives do not know how to fix the whiteness of the cloths and thus it occurs that in the course of time and washing they become reddish.

The cultivators of abacá put their fiber up in bundles, as our laborers do the *cañamo* (hemp) fiber, and each bundle weighs, as a rule, an *arroba.*[12] If they are of bandalá, they are worth 5 reales de vellon; if of the tupóz, 7.5; if of lupís, 12.5. They are carried for sale to the market, where the women, who have to work them into cloths or ropes, gather to buy them. I have seen the cloth shops in Nabua, and learned there that it takes a woman seven days to warp and weave one piece. The coarser ones, called *tinagsad,* are worth 8 reales de vellon, and are 4 yards long, and with these the women clothe themselves in the season of planting. Others, somewat better, called *bondoy,* serve for dresses, and their value is 5 reales when not stained or have somewhat more work in the design, when they bring twice the price. The *binacol* is more beautiful and costly, and the *piring-piting*[13] is very fine and worth a gold dollar. I have seen other excellent ones woven in Nueva Caceres, called *cambayes,*[14] fine and of beautiful colors, which serve for the waists of the rich ladies. Into these cloths, beside abacá, cotton and silk enter.

In general, from the abacá, cloth is woven for robes, shirts, curtains, table-cloths and couch covers, varying in designs and colors, according to the use for which each piece of work is destined. There is such an abundance of the material, so the most Illustrious Mr. Collantes informed

[9] Such a stripper as is here described seems to be unknown now.—E. B. C.

[10] The notably lustrous cloth produced in Albay as a result of pounding is called *pinalpog,* literally, pounded.—E. B. C.

[11] Half a yard is about the actual width of this cloth now. The Spanish vara or yard is 33 English inches.—E. B. C.

[12] An arroba is 25 pounds.—E. B. C.

[13] Piring-piting means a whirling motion, or something whirling.—E. B. C.

[14] This name is applied only when the colors are mixed.—E. B. C.

me, that the towns of Cagsavá, Camalig, Guinobatan, and Ligao yield, each, 1,500 arrobas of cordage and about as much more in the Province of Albay, which the king receives, laid down in Cavite at 30 reales de vellon an arroba. They usually extract some thousand bundles of sinamay, each one of one hundred twenty pieces. With these and the abacá, the natives pay their taxes and parochial rites, and the cost of their feasts, clothe themselves, and buy what they need.

In the factories of Nueva Caceres, they make an astonishing quantity of cordage, which is carried by the river as far as Arugai, and then by land to the warehouse of Pasacao. The last stretch, which is more than 3 leagues, was formerly very arduous; but to-day it is easy, since the Governor, D. Manuel Ledaros, ordered a fine and solid road for carts to be built.

It is strange that neither Linnæus nor the modern botanists have spoken of a plant so well known and of such great use in the Philippines, in spite of its having been pointed out by Rumphius in the place cited; of his having said that its fruits are very small, useless and hard; and of his having related that in Mindanao cables are made of the hard exterior fiber of the trunk and cloths of the interior ones. He called it *silvestre* because he thought it was not cultivated in Mindanao nor Luzon; but, knowing now the care given to its cultivation, and that it is the only species of *Musa* which yields fibers useful for such manufactures, it seems to me that it ought to be distinguished from the other species, and be called in the future *Musa textilis*. Although I have seen many thousands of them, I have never succeeded in seeing the flower.

I have not succeeded so badly with the other species and varieties, of which I have been able to distinguish up to twenty-seven, in the Island of Luzon alone, taking for characters the variable size of the leaves, the colors of the spathes, and the size and taste of the fruits. Accordingly, leaving unsettled for the present the number of true species, I will relate what long experience and repeated observations have taught me about the flower.

I know that the European botanists, after having seen one flower or another in the greenhouses, affirm that they consist of six stamens, and that not all are perfect. Without censuring this proposition, established by Linnæus, confirmed by Trew, and followed by many, I must repeat what Scopoli said, which is that the flowers of the plantain or *Musa* are always found perfect, and with five stamens, without the least rudiment of a sixth ever being discovered. This character brings it near to *Heliconia*, and removes it from the place where Linnæus put it in his system. My observations were uniform, not only in the Philippines, but also in the Friendly Islands, in Peru, in Africa and in New Spain, and in conformity to them I have had made the drawing which I keep. Thus, then, I believe that the generic character should be reformed in this manner.

Calyx, a partial spathe, ovate-oblong, concave, with many flowers.

Corolla, of two petals, the upper one long, broad, truncate, with five short laciniæ, its base somewhat concave; the lower one twice as short, membranous, somewhat folded inward, retuse at the apex, with a long sharp point exceeding the notch.

Five filaments shorter than the superior petal, inserted on the receptacle, inclosed by the petal mentioned; the anthers honey-bearing, linear, attached in the upper middle part of the filament.

Ovary oblong, with three or four obtuse angles. Style furrowed, straight, equal to the stamens. Stigmas three, somewhat flattened, thick and united, but easily separable.

Berry fleshy, like a cucumber, rather abruptly contracted, obscurely triangular, with many almost globose seeds.

Observation: The inflorescence is solitary, and the spathes are alternately arranged on it. Each one of the latter incloses nine to fourteen flowers, which open successively and are fertilized at the same time. The fruits at the base of the inflorescence are usually mature, while the latter is still growing at the end and the flowers of thirty spathes near the extremity are not yet open. The latter almost never produce fruit, in spite of having complete organs of reproduction, which may be due to the consumption, by the multitude of fruits situated near the base, of the sap which ought to reach with energy to the flowers at the tip, or to the want on the part of the distal flowers of the necessary strength to purify the large amount of thick and aqueous liquor inclosed in the spathe, so that they blast and decay.

It is noted that Née identifies his abacá plant with the *Musa silvestris* of Rumphius. If this supposed identity had been a dominant feature of Née's publication, then Rumphius's plant, whatever it was, might be the type of *Musa textilis* Née; but it is evident that Née's principal concern was to name and describe a Luzon plant, as a species essentially new to systematic botany, and that the reference to Rumphius is incidental. The type locality of *M. textilis* is in Camarines; and, although there is specific reference to the town of Nabua, it can hardly be located more definitely.

It is perfectly clear that Née intended to include in his species any and all *Musa* plants characterized by the production of fiber rather than of fruits; but even superficial observation of the various fiber-producing *Musas* shows that, according to the more modern conception of "species," these plants represent not one species, but several, and more careful study of their botanical characters makes this fact only clearer. Before an attempt to give a botanical status to these natural species can be made, it is necessary to identify some one of them as typical *M. textilis*, thus giving to this name a more definite and restricted use than its author intended. For this purpose, we have a medium of description, and a collection of vernacular names which might identify a definite type locality, and thus help to identify a particular plant.

Consultation with many Bicol students and correspondence with teachers in Camarines and Albay have made it appear that Née's vernacular terms cannot be used to identify any locality. Some are general, and some are unknown, at least as he uses

them, to any of my informants. However, his citation of names of varieties can be made of use.

As to description, we are told that Née regarded abacá as a plant ready to strip eighteen months after planting, mature in twenty-four months, with fruit 1.5 to 2 inches in length, with a trunk reaching a total height of 7 feet, so that the cut trunk is 5 feet long. We are also given, as native Bicol names, agotai, agotag, and amoquid, the last two not distinguished.

This description certainly applies to a plant smaller than most cultivated abacá, and quicker to mature under the conditions and treatment usual in Bicol territory.

Turning again to the vernacular names: Agotag is apparently not a Bicol word; but agotay can be applied to the same plant as amoquid. The use of final "i" or "y" is optional, and in the notes of Née or his informant "y" might very easily have been mistaken for "g." Instead of three names, then, we have probably only two. Amoquid is recognized by any Bicol as a word referring to a mountain, derived from *boquid,* or *buquid,* a mountain. T. N. Vibar sends me: "Amoquid—A variety of abacá, small, tapering and with stiff fibers, without much commercial value." Most Bicols know no variety by this name, and construe the term as applying to the habitat only.

Regarding agotai, Mr. Vibar writes:

> Agotai: The name of the fruit and the plant belonging to the genus *Musa,* growing in forests, now extinct in cultivated plantations; called by the natives "Banana Utong" or "Monkey Banana;" fruit edible, but containing many seeds.

Mr. E. H. Koert writes:

> Agotai: Species of small wild banana, also known as "Batag ñg okai" or monkey banana.

Edible fruit is not a constant feature of plants regarded locally as agotai. Also, although not as a rule, the plant is found in plantations, and this may well have been true in general more than a century ago, before the cultivation of abacá became a great and long-established business. In this connection, Mr. Koert writes, regarding amoquid:

> It appears that this is the only genuine wild hemp or abaca and the many varieties that now occur are merely the result of mutations and cross fertilization with "agotai." In new districts where abaca suckers are only to be had with considerable cost and labor it is still the practice to make a caiñgin and leave the seeds, carried by birds and animals, to grow up in the new clearing. In this virgin soil the plants shoot up rapidly and even the first generation is stripped to some extent and mixed

with abaca from longer cultivated fields. The third generation of suckers growing from the bird-planted seed produces most of the coarse grades of fiber. After the third generation the fiber gradually becomes finer and finer.

Mr. Celedonio Salvador, of Iriga, is likewise convinced that "Sa Mequid" represents Née's plant; but in his locality the word "agotai" is not used as the name of a variety, and his description of the plant as a whole does not show that it differs from the agotai of other places.

Mr. Vibar is equally of the opinion that agotai is the original wild parent. Both of these opinions are supported by other informants, agotai being more generally recognized as a specific form, being more commonly so regarded.

Taking into account the scanty items of Née's description, the present use of the vernacular varietal names he cites, and the fact that he wrote when the abacá industry was comparatively undeveloped, we may conclude with considerable confidence that typical *Musa textilis* is now to be found in the mountains rather than in the plantations of Camarines. Whether this conclusion carries in itself the identification of a type, or whether it remains to choose a type among two or more wild species, can be determined only after reasonably careful collection in the locality. It can of course hardly be doubted that *M. textilis* is represented in the Bicol plantations, whether or not by a typical form; but it is neither proven nor probable that all or most of the abacá cultivated there is descended from any local wild plants. One of the commonest cultivated "varieties" is called "Sa Moro," a name indicating almost certain introduction from Mindanao.

Perrottet's description of *Musa abacá* was published in French, and is translated as follows:

Musa Abaca Perr. I give to this new species of banana plant the name it bears among the Indians of the Philippines. It differs from the others of its genus, by its longer, narrower, firmer, and beautifully dark green leaves, by the thickness and considerable height of its stalk, of a brilliant deep, green color. Its fruit seems never to be well fastened. From its stalk is extracted a sort of fiber, of the greatest tensile strength, from which are made cables and cordage which are very durable and resist the most violent storms. There is also made of it cloth of very fine texture, susceptible of perfect bleaching and rivaling the most beautiful linen.

The natives multiply this plant by means of the suckers which the roots provide abundantly; they cultivate it with a certain fondness and have it in the neighborhood of their homes, where it forms considerable patches; but it thrives only where the soil is rich in humus and moist

rather than dry, where it is protected from the wind. It is a native of the forests, and abounds in humid and shady places.—C. M.

There is nothing in this, beyond large size and green stem, which might suggest any particular plant (for the leaf characters are those of "abacá" in general), and these features are not those of *M. textilis*. There is no note of place of collection, within the Philippines, nor does it appear that the plant was collected. The account is probably no more than a traveler's general impression. Under the circumstances, the best that can be done with *Musa abaca* is to relegate it to the limbo of "species ignota," though the name may be given to one of the tall, green forms, if study shows one of these to be entitled to recognition as a species.

TRANSLATION FROM BLANCO'S FLORA DE FILIPINAS (1837) 246–250

Musa Troglodytarum. Musa of the Troglodites. The spadix inclines toward the earth when the fruit is already big. Before this, erect, as is generally the case in other species. *Flowers*, each bract of the scale covers some twenty little flowers. *Corolla*, as in the variety *Ternatensis* (flowers: each bract covers some twenty little perfect flowers, the inferior petal ends with a pit in the outer part; the superior petal is cleft at the end into five segments of which the longer ones are cucullate), stamens and anthers as in the variety of *compressa* (this has five perfect stamens and the rudiment of a sixth; the anthers are very large and covered with abundant powder). Fruit like that of *ternate* (with three prominent angles, or at times four or five, and crowned with a flower which persists until the fruit is mature) and full of very much depressed round seeds with a navel.

This very common plantain produces seeds, all perfect, from which it takes its name. The fruit, which is of ordinary size, is used to make vinegar and can also be eaten, since it is likewise savory. A buffalo maintained for some months on the trunk of this plantain without other food lost its teeth, though it was quite young, which is singular indeed. Drinking the water which collects in the cut-off base of the trunk has a great reputation to cure the contraction of the virile member. *T. Botohan, Botoan.*

Musa Troglodytarum errans. Musa of the troglodites erratic. Each scale covers some twenty little flowers. *Corolla*, the superior leaf with five laciniæ, the two alternate ones smaller; the inferior leaf much shorter, with little teeth at the apex inconspicuous, and without any pit in the outer part of the base; there is likewise no rudiment of the sixth filament. Fruit with three to five ridges, full of perfect seeds. This rare plantain grows spontaneously in the woods, and its height and bearing are those of other varieties. The spadix is almost an arm span in length and the bracts of the spathe are green and not colored. The fruits are not much larger than the middle finger, and cannot be eaten even when mature, because of their bitterness. They are full of black seeds when ripe, and with a single *raceme* this plantain might be easily extended over a whole

province, and perhaps it would be well to do this, because its threads have seemed to me to be stronger than those of the abacá, which it is much like; and perhaps the former has given origin to the latter which is already cultivated and with edible fruit. The one I am speaking of grows in the mountains of Tala. *T. Saguing Machin, Saguing na ligao.*

Musa Troglodytarum Textoria. Musa of the Troglodites for cloth. Corolla, the inferior leaf almost without incisions. Stamens five, without a rudiment of a sixth. Fruit with three ridges, and many perfect seeds. This plantain called abacá I regard as a variety of the *compressa;* it is one of the most useful and is cultivated with care in the province of Camarines and other parts. At the first sight, it is not distinguished from the other. The fruit is very small, for that which I have seen scarcely exceeded two inches in length. The seeds mature completely. The use made of this plantain is very great. From it are obtained cords, cables, and cloths of extreme fineness.

For this use, the trunk is cut at the foot and at the top when it is about to bear fruit, the leaves being removed. The petioles are removed one by one, and in the middle of each, a crosswise incision is made with a knife to remove the inner cortex. The inner cortex of the petiole being removed bands are still made of the outer part, two fingers wide, which are placed one by one under a knife blade fastened in a large bamboo which has the effect of a spring and the longer arm of which is fastened to the ground.

The strip of abacá being placed then under the knife in such a manner that the outer surface looks upward, it is then drawn forcibly through by one end, which is repeated once or twice and the threads then appear clean; but with this method, there is a loss of half of the abacá. The fibers have still to be passed through a sort of saw which has the function of a flax comb like those used in Europe for flax; this second operation I have not seen performed, but the other I have. The fibers remain there in order; but some are finer than the others and, therefore, the women must take care to separate them into various classes before weaving, which work they perform with great dexterity, even though in the dark.

If the abacá is to be employed in making cloths, a tight reel, as big as the head of a child, is first made of the fiber, which is put into a rice mortar and is given many blows with the wooden pestle of the mortar. This operation makes the abacá very flexible and less likely to break. This being done, there is nothing more except to tie the threads together by their ends, which work regularly keeps the women and children busy. The weaving is done as with cotton; but, if the abacá is too fine, the women put themselves behind curtains to weave it, because the wind may easily break the fibers.

The cloths being made, they are placed for a day and a night in water with a little shell lime. They are afterward washed and stretched.

Although the abacá is sufficiently strong, it is very inferior to linen and cañamo, in this respect as well as in the luster and in "feel."

The abacá does very well in the province of Batangas and in other parts; but it is not as good as that in Camarines, and the latter appears inferior also to that of Panay and Marinduque; but regarding this opinions differ.

The fruit is eaten, and the water which collects in a hollow made in the base of the trunk, after it is cut, is said to be good for the contraction of the virile member, a singular disease which has not ceased to be frequent

in the Visayan provinces, and which is regularly accompanied by the contraction of the tongue.

The Englishman Dampier was mistaken when he said that abacá was known only in Mindanao.

The abacá stains easily with blue and red. To stain it with blue, there are employed since olden times the leaves of a bush or vine which in Camarines is called *payanguit* and *aringuit*, according to the sage report made about this vine to the Economic Society of Manila by the curious and diligent observer Father Jose de Mata, a Franciscan brother, the same who has recently made this vine known to the Europeans in the Philippines. The leaves of this bush give a very abundant blue color. *V. Marsdenia.*

To stain abacá red, I have heard that in Camarines they boil the cortex of the root of the *Morinda* with a little lime or alum until the desired color is produced, and proceed with this to the dyeing; but it is better to dye it in the manner usually used with cotton thread; that is, with lye and oil of sesame. *T. Abaca.*

Note: The last two plantains have been included here in order to put those with thick peels together in one place.

The name *M. Troglodytarum* cannot be given properly to any of these plants; it applies to *M. uranoscopos* Rumph., a plant with erect infrutescence. I have included a translation of the description of *M. Troglodytarum errans*, because of a suspicion that this plant is real *M. textilis*. Teodoro, [15] has already suggested that it may be the agotai of Albay, and has raised Blanco's variety to specific rank. "Saguing machin" means, again, "monkey banana." Teodoro's figures as to stature (4 to 5 m) would represent a very abnormally tall forest specimen.

Blanco, like his predecessors, evidently intended to describe abacá in general, and omitted observations on color and stature peculiar to the various kinds. As he gave no possibly valid specific name, this raises no nomenclatorial difficulties.

Teodoro, in the publication just referred to, has given a rather complete description, with figures of flowers and fruit, of the abacá plant commonly cultivated in Laguna. It remains to be determined, from a study of agotai and amoquid, whether or not it can be identified reasonably as *M. textilis* Née.

The description of *Musa sylvestris*, by Colla, [16] is translated as follows:

3. Musa Sylvestris. A Musa with the spadix subnutant, sterile and staminate flowers deciduous, the stipe and polygonous fruit turning black.

. . . . . .

M. sylvestris Pissang utan: Rumph Amb. page 139. Bananier Coffo Desv. page 38 n. 29.

[15] Philip. Journ. Sci. § C 10 (1915) 379.

[16] Memoria sul Genere Musa, etc., Mem. Accad. Sci. Torino 25 (182?) 386.

Habitat, Philippines, and especially, Mindanao.

. . . . . .

This rather than *Musa Troglodytarum* is probably the mother of all the species, which Willdenow calls seedless, for it carried the spadix nodding, not erect, and in special characters agrees notably with *Musa paradisiaca;* its substance is more solid and harder than in other species, the fruits are of the form of *M. paradisiaca,* but smaller, never maturing or turning yellow, hard, and filled with many drupelets; this is the species from the threads of which the people of Mindanao weave garments, which they call Coffo and for which they are employed by the magnates.

I have retained the name given by Rumphius, because this species alone, he said, was truly *silvestris,* and not cultivated.

The translation of Miquel's description [17] of this plant is as follows:

3. *Musa mindanensis* Rumph. Herb. Amb. V. p. 139. Lofty and stout, the trunk turning black, as stout as a coconut trunk, the leaves firm, large, deep green; spadix nodding; mature fruits greenish, unequally polygonous, *Musa sylvestris mindanensis* Rumph. l. c. *M. Troglodytarum* B. Wild. Spec. pl. I. p. 894. *M. Balbisiana* Collad. Hort Ripul. l. c. *M. textilis* Luis Nee in Annales Ciencias naturales IV. p. 123. A striking distinct form with whitish trunk is reported by Rumphius. In the woods of Mindanao, Sangir, Gilolo, Celebes, etc. Pisang utan in Malay. Kula abal in Amboinese. Fana in Ternatese. Koffo in Minahassa, the Philippine Islands, etc. The fibers, obtained from this species, are of exceptional tensile strength, and have long been woven into fine cloths.

The description of Rumphius, referred to by Colla and Miquel, is translated as follows:

Musa silvestris. Pissang Utan.

Another but larger forest species of *Musa* is in certain islands deeply sylvan by nature, when it is cultivated by nobody, but takes care of itself; but in certain islands it is sylvan, indeed, by nature, but has its owners because of its uses, and thence we distinguish it as "Mindanauensis" and "Amboinensis."

First, *Mindanuensis* is a great, tall tree, having the thickness of a coconut and the height of the sugar palm, usually blackish on the outside, but one form of it is green or whitish like other *Musas,* but not of as good reputation. It is composed likewise, of many sheaths placed one over another, its substance really being much more solid and harder, and the leaves likewise are commonly larger, darker, greener, and more firm.

Its fruits are of the form of "Pisang batu" (saguing bato, stone banana), but smaller, never maturing or turning yellow, hard, filled with numerous seeds, unsavory, and not fit to eat, though if they are sucked out they are sweet. The forest form of this species bears a shorter trunk.

An account of localities, names, and uses follows, but there is nothing more of a descriptive character.

[17] Flora Ind. Bat. 3 (1855) 588.

Now this description, like Née's, lacks almost everything of being an adequate diagnosis; but there is one character which stands out, and that is the remarkable stature, and nothing else that could have been said about it would have marked it so unmistakably as a different plant from that later described by Née.

It remains, then, to determine by field work a type of *Musa silvestris* in Mindanao, as of *M. textilis* in Luzon. Since southeastern Mindanao lies nearest to the Moluccas, whence Rumphius heard of this plant, and nearest to Sangir, where it was also reported, it is in that part of the island that the type would most reasonably be sought. There is, both wild and in common cultivation, in Davao, a plant which fits the limited description satisfactorily; and, so far as I know, there is only one such plant. The fixing of this type promises, therefore, to be easy.

BLOOD-CHEMISTRY STUDIES IN LEPROSY, II. THE ALKALI RESERVE [1]

By Ernesto M. Parás

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The acidimetric condition of the blood has for some time been recognized as having a most important relation to the fundamental vital processes, and a number of methods have been developed, in the past two decades, for the chemical study of this condition in health and in disease.

Advanced nephritis, diabetes, starvation, and most fevers have been found to be associated with a depletion of alkali. In tuberculosis and syphilis little or no change from the normal has been noted. Increased alkali has been observed in cases of cancer, persistent vomiting, and after administration of alkaline drugs such as sodium bicarbonate.

In leprosy no work on this subject has come to our attention, beyond certain clinical observations,[2] made by some physicians in this colony, that alkaline treatment is beneficial in cases of lepra reaction. The investigation reported in the present paper is a preliminary survey of the acidimetric condition of the blood in patients at Culion, grouped as far as possible into representative classes.

Van Slyke's method of determining the alkali reserve was chosen. Although a complete survey of the acidimetric condition of the blood would require also determination of the hydrogen ion concentration, it is believed that Van Slyke's method alone is sufficient for the cases investigated, for the reason that impairment of circulation or ventilation could

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The first paper of this series was published in the Philippine Journal of Science 30 (1926) 219–234.

[2] Compare Catalino Nicolas and Luis B. Delgado, Journ. P. I. Med. Assoc. 6 (1926) 373–380.

practically be eliminated as causes of disturbance, according to the statements of the attending physicians.[3]

Where our values are very high, uncompensated alkalosis (Van Slyke's area I) is certain, unless there was markedly deficient ventilation. Among cases of moderately high value considerable uncompensated alkalosis is to be expected. (These cases will be discussed later in the paper.) Our normal values indicate the normal condition (area 5), and most of the low values,[4] "compensated acidosis" (area 6). Meyers and Booher state—

> in those cases of abnormal balance due to alkali deficit, which after all constitute much the largest clinical group, the bicarbonate appears to be entirely adequate so long as the values do not fall below 35.

TECHNIC

About 5 cubic centimeters of whole blood were collected under oil in a test tube containing a few powdered crystals of potassium oxalate.[5] With very few exceptions, withdrawal of blood was done between 9 and 11 o'clock in the morning.

The sample was centrifuged and the separated plasma saturated with carbon dioxide at the alveolar tension of the writer. The plasma total carbon dioxide was then determined in 1 cubic centimeter at room temperature. In a few instances 0.5 cubic centimeter was used. The determinations were usually performed within seven hours from the time the blood was drawn. Occasionally, however, the samples were centrifuged and then kept overnight in the refrigerator, covered with paraffine oil and well stoppered. As a check on the possible influence of standing upon the alkali reserve, two specimens of normal blood were tested after standing five hours and twenty-two hours, respectively; the results thus obtained showed no appreciable change. Specimens that were partially coagulated or contaminated by hæmoglobin were rejected.

At the start of the work, duplicate examinations were made of each sample. Since the duplicate results generally agreed exactly and always within 0.02 cubic centimeter, single deter-

[3] For a discussion of the relation between alkali reserve and hydrogen ion concentration the reader is referred to Myers, Pract. Analysis of Blood, 2d ed., 96–120, and to Stitt, Pract. Bact. Blood Work, Parasitology, 7th ed., 655–665.

[4] Meyers, V. C., and L. E. Booher, Journ. Biol. Chem. 59 (1924) 711.

[5] For complete details of the method the reader is referred to Van Slyke, Journ. Biol. Chem. 30 (1917).

minations were used thereafter if the results were within normal limits. Abnormal results were always checked.

As to the effect of diet, a thorough study on this subject has been made by J. F. McClendon [6] and his coworkers, who concluded that the alkali reserve is remarkably resistant to such influence.

RESULTS AND DISCUSSION

THE ALKALI RESERVE OF NORMAL INDIVIDUALS

For the purpose of comparison twelve healthy adults were examined, five of whom were professionals and seven laborers. The results are grouped in Table 1. It can be seen that the range of carbon dioxide reading is from 60 to 78 volume per cent, with an average of 70. The values obtained from the laboring class appear to have much wider limits of variation than do those from the professional staff. This may be because the conditions of activity, occupation, and probably diet, besides other factors, were more nearly uniform in the latter class than in the former.

In Table 2, the range of values obtained by other investigators for normal individuals is compared with the data I obtained. From this table it can be noted that the normal values given by Van Slyke and Cullen and by Gettler and Baker vary more widely than do Cullen and Robinson's, Jonas's, or mine. This difference in variability may be attributed to the differences of conditions as above stated (age, activity, occupation, etc.), that may be encountered for different individuals, so that when normal persons are taken at random, greater variations are likely to be obtained. At least, this holds true in the present instance. Another example is that of Cullen and Robinson,[7] who took for their normal individuals medical students whom they examined while these students were at class work between 10 and 11 o'clock in the morning. The readings obtained ranged from 59 to 71, showing a variation of only 12. It can also be seen that Gettler and Baker, and Van Slyke and Cullen obtained 56 and 53 volume per cent, respectively, as their lower limit for normal individuals. Jonas and I both have 60 volume per cent as our lower limit. That of Cullen and Robinson is practically the same as mine. Van Slyke stated that a great majority of plasma specimens obtained

[6] Journ. Biol. Chem. 38 (1919) 539.
[7] Journ. Biol. Chem. 57 (1923) 533.

by the use of McRae needles show figures between 60 and 70. For the present, therefore, the values of 60 and 78 may be taken as the lower and upper limits, respectively, for normal individuals.

THE ALKALI RESERVE IN LEPERS

(*a*) *Uncomplicated leprosy.*—Table 3 shows the carbon dioxide percentages for cases of uncomplicated leprosy. These readings range from 60 to 83, with an average of 67.9, which is practically 2 lower than the normal average. Most of the values are between 60 and 70 and only two are above 78, the upper limit for normal individuals. It may be stated, therefore, that leprosy alone is not accompanied by significant change in alkali reserve. No correlation could be found between the alkali reserve and the duration, type, advancement of leprosy, the antileprosy treatment, or the age of the patient. Practically all of the patients examined were adult males. Since no conclusion could be drawn as to the relation of the values to the sex, and to economize space, this item is omitted in the tabulations.

(*b*) *Lepra reaction without alkaline treatment.*—In the group of patients having lepra reaction without alkaline treatment (Table 4) the carbon dioxide readings ranged from 52 to 78 volume per cent. Out of twenty cases examined, three were below 60 and the rest had normal values. The average is 66.5 per cent, which is 3.5 per cent lower than the normal average. From this average it appears that in lepra reaction there is a tendency toward reduction of alkali reserve, although most of the individual cases gave readings within the normal limits.

(*c*) *Lepra reaction with alkaline treatment.*—In the lepra reaction cases with alkaline treatment [8] before and up to the time the blood was drawn for examination (Table 5), the variation was from 64 to 98, with an average of 75.7, about 6 per cent above the average for normal individuals. Of the fifteen cases examined five gave results below 70, five ranged from 70 to 79, and the remaining five between 80 and 98. The latter range may be considered to show conditions of alkali excess. In this connection, the following comment by Meyers and Booher [9] may be quoted:

[8] For method of alkaline treatment, the reader is referred to Catalino Nicolas and Luis B. Delgado, The alkaline treatment of lepra reaction, Journ. P. I. Med. Assoc. 6 (1926) 373–380.

[9] Journ. Biol. Chem. 59 (1924) 708.

The highest CO_2 we have found associated with a high pH was 88. This figure for CO_2 capacity increased to 104 shortly before death. The lowest CO_2 found associated with a high pH was 50.

We are inclined to think that alkalosis is a condition often overlooked and sometimes confused with acidosis by the clinician. We believe that a great deal of care should be exercised in the administration of alkali. In cases with impairment of renal function the administration of alkali is a dangerous procedure, unless it is accompanied by estimations of the blood bicarbonate.

A more-detailed investigation by the medical section of the Culion Leper Colony, of lepra reaction in connection with the alkali reserve and alkaline treatment, is now in progress.

(*d*) *Leprosy with tuberculosis.*—Relative to Table 6, representing cases of leprosy with tuberculosis, it may be stated that, although the number examined is too small to warrant a definite conclusion, the findings can for the present be considered as negative. The average for this group is 72, which is only 2 volume per cent higher than the normal average. In this connection it may be mentioned that Sweany [10] could draw no conclusion after making only one hundred tests; but, by continuing the investigation to include several hundred patients, the results showed that there was an indication that the general average of tuberculosis patients had a slight tendency toward "acidosis." He concludes that—

fibroid cases have a higher average of alkali reserve than patients having the same amount for involvement more acutely.

Certain far advanced cases gave relatively high readings.

David S. Hachen,[11] in a study of two hundred thirteen tuberculous patients having every variety of lesions, also concluded that—

in tuberculosis there is a moderate depletion in the blood alkali reserve only after the lesion becomes far advanced and is accompanied by rather severe clinical symptoms, such as increased fever, chills and sweats, slight dyspnea, and general malaise.

(*e*) *Leprosy with nephritis.*—Table 7 represents cases of leprosy with nephritis. Although only a few were examined and the majority of the individual cases are within normal limits, the results show on the whole a reduction of alkali reserve. The average obtained for this group of eight cases is 61 per cent, which is 9 per cent lower than the normal average. One case (43) gave a reading of 26 per cent. This patient died about

[10] Am. Reviews of Tuberculosis 7 (1923) 193.
[11] Arch. Int. Med. 29 (1922) 705.

half an hour after the blood was drawn and autopsy findings established uræmia as a cause of death. Two other cases (46 and 80) had readings below the lower normal limit; the rest of the figures are within the normal limits. Low carbon dioxide values are the rule in severe nephritis. The normal figures found in the majority of the patients in this group may probably be considered as an index of the extent of kidney deficiency in these patients. This is in comformity with certain clinical observations [12] here relative to the frequency of extensive œdemas and low phthalein readings, which are not in accord with the comparatively frequent diagnosis of uræmia as the cause of death.

(*f*) *Leprosy with miscellaneous complications.*—In cases with miscellaneous complications (Table 8) the carbon dioxide readings range from 50 to 84 per cent, with an average of 59.6. This is 10.4 per cent lower than the normal average. Out of nineteen cases, five are below the lower normal limit. Four of these five cases have nephritis as a part of their complications. Case 17 is above the upper normal and the rest are within normal limits.

Case 19, with a reading of 42, had broncho-pneumonia when blood was drawn for examination.

(*g*) *Summarized data.*—In the summary of data for the various groups (Table 9) it will be noticed that the average value is very slightly lower than the normal average in the group of lepers having no complications, and somewhat lower still in the group with lepra reaction without alkaline treatment. In the group with lepra reaction with alkaline treatment a somewhat more marked upward deviation from the normal average may be noted. The groups of lepers with nephritis and with miscellaneous complications show markedly low averages. In the group of cases with tuberculosis, the average carbon dioxide value is about the same as the normal average.

SUMMARY AND CONCLUSIONS

1. The Van Slyke determination of carbon dioxide capacity was performed on twelve specimens of blood plasma from healthy subjects and on one hundred ten cases of leprosy classified as follows: (*a*) leprosy without complication; (*b*) lepra reaction without alkali treatment; (*c*) lepra reaction with

[12] Lara, C. B., Journ. P. I. Med. Assoc. 3 (1923) 241, 275.

alkali treatment; (*d*) leprosy with tuberculosis; (*e*) leprosy with nephritis; and (*f*) leprosy with miscellaneous complications.

2. The readings obtained for normal nonlepers range from 60 to 78 volume per cent. This variation is about the same as that found by other investigators for normal individuals.

3. Uncomplicated leprosy is not accompanied by any significant change in the alkali reserve.

4. From the study of the average readings for the various groups of cases, the following points were brought out:

(*a*) In lepra reaction most cases gave normal results; possibly reduction of alkali reserve occurs only in a severe febrile reaction.

(*b*) Characteristic readings of alkalosis were observed in some of the cases with lepra reaction who received alkali treatment.

(*c*) Significant reduction of the alkali reserve was observed in the group of lepers with nephritis and in the group with miscellaneous complications.

(*d*) Practically normal results were noted for the group of lepers with tuberculosis.

5. Determination of alkali reserve, in connection with alkali therapy, is evidently important in lepra reaction, and is valuable in the study of nephritis among lepers.

6. No correlation can be traced between the alkali reserve and the duration, type, and advancement of leprosy, or the antileprosy treatment.

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SYMBOLS USED IN TABLES

In Tables 3 to 8 the following abbreviations and symbols are used:

sl = slight.
mc = moderate, cutaneous.
sc = slight, cutaneous.
sn = slight, neural.
an = advanced, neural.
mn = moderate, neural.
ac = advanced cutaneous.

mod = moderate.
adv = advanced.
neg = negative.
C.E.I. = Chaulmoogra ethyl esters with 0.5 per cent iodine.
C.E.I.Cr. = Chaulmoogra ethyl esters with 0.5 per cent iodine and 10 per cent creosote.
W.E.I. = *Hydnocarpus wightiana* ethyl esters with 0.5 per cent iodine.
W.O.I. = *Hydnocarpus wightiana* oil with iodine.
W.O.E. = *Hydnocarpus wightiana* oil with 20 per cent eucalyptus oil.
W.O. = *Hydnocarpus wightiana* oil.
0 = No antileprosy drugs were given.
? = No record.

TABLE 1.—*The alkali reserve in normal nonlepers.*

[Carbon dioxide bound as bicarbonate in the plasma.]

Name.	Nationality.	Plasma CO_2 capacity, volume per cent.	Remarks.
H. W. W.	American	75	Professional.
G. A. P.	do.	72	Do.
E. V. P.	Filipino	72	Do.
E. M. P.	do.	78	Do.
T. B. V.	do.	72	Do.
E. E.	do.	66	Laboring class.
I. L.	do.	77	Do.
A. M.	do.	60	Do.
S. G.	do.	70	Do.
A. A.	do.	74	Do.
B. R.	do.	68	Do.
F. L.	do.	62	Do.
Average.		70	

TABLE 2.—*Normal range of alkali reserve as given by various investigators.*

[Carbon dioxide bound as bicarbonate in the plasma.]

Investigator.	Nationality studied.	Plasma CO_2 capacity, volume per cent.	Variation, volume per cent.	Average.
Cullen-Robinson [a]	American	59 to 71	12	67.6
Van Slyke-Cullen [b]	do.	[c] 55 to 76	23	
Gettler-Baker [d]	do.	56 to 78	22	
Jonas [e]	do.	60 to 70	10	
Parás	American and Filipino	60 to 78	18	70

[a] Journ. Biol. Chem, **57** (1923) 534.
[b] Journ. Biol. Chem. **30** (1917) 308.
[c] "60 is the minimum normal figure if venous blood is drawn under oil and 53 when blood is drawn with momentary exposure to air (McRae needle)."
[d] Journ. Biol. Chem. **25** (1916) 211.
[e] Therapeutic Gazette **44** (1920) 468.

TABLE 3.—*The alkali reserve in cases of uncomplicated leprosy.*

[Expressed in volume per cent of carbon dioxide combined in the plasma.]

Case No.	Age in years.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs used.	CO_2 combining capacity.
		Years.				
7	41	7	Cutaneous	sl	C. E. I	64
8	37	12	Mixed	sl	do	64
9	20	7	do	mc sn	do	61
14	16	3	do	mod	do	62
18	22	3	Cutaneous	adv	do	72
22	26	9	Mixed	sc an	C. E. I. Cr	76
24	26	14	do	sc sn	C. E. I	68
29	53	5	do	mc mn	do	72
31	25	6	Cutaneous	sl	do	62
32	16	2	Mixed	mod	do	66
33	21	11	do	adv	W. O	76
36	27	4	neg	neg	C. E. I. Cr	83
38	24	6	Mixed	sl	C. E. I	70
40	41	7	do	mod	do	66
47	39	5	do	mod	do	72
48	39	10	do	adv	do	60
49	40	10	do	mod	C. E. I. Cr	68
51	20	8	do	sc mn	C. E. I	73
61	19	3	do	mod	W. O. I	70
64	65	10	Neural	sl	do	76
65	28	8	Cutaneous	mod	C. E. I. Cr	64
66	18	5	do	mod	do	70
67	22	10	Mixed	sc an	do	80
72	21	3	do	mod	C. E. I	60
73	27	4	do	sl	W. O. I	70
74	52	15	do	mod	C. E. I. Cr	72
75	35	17	do	mod	C. E. I	64
77	28	5	do	mod	do	64
78	50	12	Neural	adv mc mn	do	70
82	39	5	do	mc mn	do	74
88	47	6	do	mod	do	68
89	26	2	Cutaneous	mod	do	64
90	63	12	Mixed	sc sn	C. E. I. Cr	66
93	37	8	do	mod	do	66
94	24	14	Neural	neg	C. E. I	60
95	21	5	Cutaneous	sl	C. E. I. Cr	64
98	32	5	do	sl	C. E. I	64
99		5	do	sl	W. O. I	60
100	36	20	Mixed	adv	C. E. I	70
102	26	3	do	mod	do	64
107	31	6	Neural	neg	do	68
Average						67.9

TABLE 4.—*The alkali reserve in cases of lepra reaction (without alkaline treatment).*

[Expressed in volume per cent of carbon dioxide combined in the plasma.]

Case No.	Age in years.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs.	CO_2 capacity.	Clinical types[a] and remarks.
		Yrs.					
1	22	2	Mixed	mod	W. E. I	74	II.
2	33	3	do	mod	do	64	III.
3	19	4	do	mod	C. E. I	74	II, III.
10	20	8	do	mc sn	do	69	III, mod.
11	36	?	do	mod	do	76	III.
12	36	3	do	adv	do	78	II.
15	36	8	do	sc sn	do	63	VII.
28	23	4	do	adv	W. O	62	Mild.
30	20	10	do	mod	do	76	IV.
43	17	3	do	mod	C. E. I	68	III, VIII, subsiding.
50	19	5	do	sc sn	C. E. I. Cr	74	III.
58	22	5	do	mod	W. O. E	52	II, severe, with chills.
63	17	5	Cutaneous	adv	C. E. I	68	IV.
70	24	?	Mixed	sl	C. E. I. Cr	68	III.
84	17	4	do	sc sn	C. E. I	62	II.
85	18	10	do	mc sn	W. O	57	III.
86	17	5	Mixed	mc sn	C. E. I	64	IV, mod.
96	12	3	do	sl	do	52	Moderately severe.
108	25	9	do	mc an	W. O	66	VII.
Average						66.5	

[a] Clinical types of lepra reaction, according to classification followed by the medical section, Culion Leper Colony:

I, Acute reaction of old lesions, with or without appreciable fever.
II, Eruptions of new lesions without reaction of old lesions.
III, Reactions of old lesions with eruptions of new lesions.
IV, Successive eruptions.
V, Febrile with delayed cutaneous reaction.
VI, Febrile attacks, prolonged and severe without cutaneous reactions.
VII, Neuritic manifestations with or without demonstrable neuritis.
VIII, Rheumatoid manifestations; arthritic, muscular, or both.
IX, Conjunctivitis, iritis, or other ocular manifestations only.
X, Orchitis.

TABLE 5.—*The alkali reserve in cases of lepra reaction (with alkaline treatment).*

[Expressed in volume per cent of carbon dioxide combined in the plasma.]

Case No.	Age in years.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs.	CO_2 capacity.	Clinical types and remarks.
		Yrs.					
16	28	6	Mixed	mc sn	C. E. I	80	Severe.
20	20	6	do	mod	do	80	Moderately severe.
21	27	6	do	ac mn	W. O	78	Protracted.
23	31	4	do	adv	W. O. I	64	IV, mild.
26	27	5	do	mod	C. E. I	68	Repeated.
41	24	12	do	adv	W. O. I	98	III.
42	20	6	do	mod	C. E. I	82	III, VIII, subsiding.
53	26	7	do	mc sn	C. E. I. Cr	73	VIII, III.
54	34	6	do	adv	W. O	66	III, IX.
55	41	4	do	mod	do	68	Mild.
60	25	4	do	mod	C. E. I	68	Moderately severe.
62	36	4	do	mod	W. O. E	86	Recurrent.
71	23	13	Cutaneous	ac	W. O	74	IX.
83	22	11	Mixed	mc mn	C. E. I	74	III, VIII.
104	45	8	do	mod	do	74	III, VIII.
105	14	4	Cutaneous	sl	W. E. I	68	IV.
Average						75.7	

TABLE 6.—*The alkali reserve in lepers with tuberculosis.*

[Expressed in volume per cent of carbon dioxide combined in 100 cubic centimeters plasma.]

Case No.	Age.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs used.	CO_2 combining capacity.	Advancement of tuberculosis.
	Years.	*Years.*					
25	18	7	Mixed	sl	0	69	mod. adv.
37	41	16	do	adv	0	78	adv.
39	27	5	do	mod	C. E. I	72	
45	31	5	do	sc an	0	73	adv.
56	28	12	do	adv	0	75	adv.
92	21	13	do	adv	0	70	adv.
103	26	3	do	mod	C. E. I	68	adv.
Average						72	

TABLE 7.—*The alkali reserve in lepers with nephritis.*

[Expressed in volume per cent carbon dioxide combined plasma.]

Case No.	Age.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs used.	CO_2 combining capacity.
	Years.	*Years.*				
4	26	8	Mixed	adv	0	70
46	59	10	do	adv	0	58
59	42	8	Cutaneous	adv	0	26
68	29	3	Mixed	mc sn	?	78
76	39	5	do	sl	C. E. I	70
80	59	6	do	adv	W. O. I	58
101	27	11	do	mod	C. E. I	62
109	40	12	do	mod	0	66
Average						61

TABLE 8.—*The alkali reserve in lepers with miscellaneous complications.*

[Expressed in volume per cent of carbon dioxide combined in 100 cubic centimeters plasma.]

Case No.	Age.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs.	CO_2 combining capacity.	Remarks.
	Yrs.	*Yrs.*					
5	23	4	Mixed	adv	W. O. I	68	p. t. b., incipient: nephritis, chronic; ankylostomiasis; ascariasis; secondary anæmia.
6	23	5	do	mod	W. O	63	Lepra reaction III, VIII, severe; nephritis, chronic.
13	20	4	do	adv	W. O. I	72	Lepra reaction IV, VII, VIII, severe; p. t. b.; ankylostomiasis; secondary anemia; treated with alkaline drugs.
17	28	4	do	mod	C. E. I	84	Abscess post injection, etc.
19	37	21	Cutaneous	adv	W. O. I	42	Broncho-pneumonia.
27	14	3	Neural	sl	W. O. I	76	Measles.
34	31	7	Mixed	adv	C. E. I	50	Cardiac dilatation; nephritis, chronic; p. t. b.
35	41	10	do	adv	0	66	Lepra reaction IV; nephritis, chronic; p. t. b.; treated with alkaline drugs.
44	32	16	do	sc sn	W. O. I	58	Malaria, acute; nephritis, chronic; temperature 40.7°C.

TABLE 8.—*The alkali reserve in lepers with miscellaneous complications*—Continued.

Case No.	Age.	Duration of leprosy.	Type of leprosy.	Advancement of leprosy.	Antileprosy drugs.	CO_2 combining capacity	Remarks.
	Yrs.	*Yrs.*					
52	29	7	Cutaneous	mod mc	W. O	64	Malaria, malignant.
57	34	14	Mixed	ac mn	W. O	72	Lepra reaction IV, VIII; nephritis, chronic; treated with alkaline drugs.
69	25	14	do	adv	0	73	p. t. b.; nephritis, chronic.
79	39	10	do	mod	0	62	Nephritis, chronic; p. t. b.
81	30	8	do	adv	0	66	Lepra reaction; nephritis, chronic; anæmia.
87	52	11	do	ac mn	0	54	Nephritis, chronic; lepra reaction IV; osteoarthritis, right knee.
91	34	6	do	adv	0	68	Nephritis, chronic; lepra reaction.
97	16	6	Cutaneous	mc	W. O	76	Nephritis, chronic; lepra reaction; treated with alkaline drugs.
106	25	11	Mixed	adv	0	58	Lepra reaction; nephritis, chronic; ankylostomiasis; secondary anæmia.
110	37	5	do	mc sn	C. E. I	69	Nephritis, chronic; lepra reaction II; secondary anæmia; ankylostomiasis.
Average						59.6	

TABLE 9.—*The alkali reserve; group range and average.*

[Expressed in volume per cent carbon dioxide combined in 100 cubic centimeters plasma.]

Table.	Condition of cases.	Range.	Average.
1	Normal nonlepers	60 to 78	70.0
3	Lepers without complication	60 to 83	67.9
4	Lepers with lepra reaction (without alkaline treatment)	52 to 78	66.5
5	Lepers with lepra reaction (with alkaline treatment)	64 to 98	75.7
6	Lepers with tuberculosis	68 to 78	72.0
7	Lepers with nephritis	26 to 78	61.0
8	Lepers with miscellaneous complications	50 to 84	59.6

SALTS OF ALPHA LINOLIC TETRABROMIDE (SODIUM, POTASSIUM, ZINC, BARIUM, CALCIUM, AND STRONTIUM) FROM PHILIPPINE LUMBANG OIL

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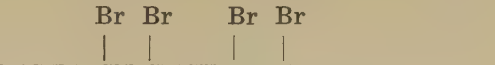
Recent experiments [1] indicated that Philippine lumbang oil contains various linolic glycerides corresponding to different linolic acids. These glycerides, together with linolenic glyceride, are the principal substances that absorb oxygen from the air and cause the oil to dry.[2] Alpha linolic glyceride is perhaps the most important of the linolic glycerides. This glyceride and the corresponding free alpha linolic acid are, therefore, substances of considerable importance. Although the glyceride and the free acid are substances that oxidize readily, they may be separated from an oil in the form of a stable tetrabromide.[3]



alpha linolic tetrabromide

Since this crystallized alpha linolic tetrabromide is a stable form of the alpha linolic compounds, it is an important substance in the chemistry of vegetable drying oils. Only a very few derivatives [4] of this substance (alpha tetrabromide) have ever been prepared and, in view of this fact, it seemed desirable to make a few salts of this substance and determine their solubility in various organic solvents. The data thus ob-

[1] Santiago, S., and A. P. West, Philip. Journ. Sci. 32 (1927) 41–52.

[2] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 42.

[3] Ibid. 1 (1921) 202.

[4] Ibid. 204.

tained may be useful in devising new methods for separating mixtures of various linolic tetrabromides.

EXPERIMENTAL PROCEDURE

Preparation of alpha linolic tetrabromide.—Philippine lumbang oil was used as the material for preparing a supply of alpha linolic tetrabromide. Lumbang oil is obtained from the seeds of *Aleurites moluccana*. It is a drying oil and is used in making paints, varnishes, and similar products.[5] The lumbang oil was pressed from seeds of good quality and filtered, first through glass wool and then through filter paper. Lumbang oil consists almost entirely of the unsaturated glycerides of linolenic, linolic, and oleic acids.[6]

The alpha linolic tetrabromide was prepared from lumbang oil in accordance with the procedure adopted by Santiago and West [7] in a recent investigation of lumbang compounds. The lumbang oil was saponified with aldehyde-free alcoholic potassium hydroxide.[8] The mixed potassium soaps thus obtained were converted into the mixed acids. The mixed acids were brominated in ether solution, according to the procedure used by Imperial and West [9] in preparing linolenic hexabromide. The ether solution of mixed acids was stirred mechanically by means of a hot-air motor and brominated at — 10° C. The insoluble linolenic hexabromide was removed by filtering. The ethereal filtrate from the hexabromide was treated with sodium thiosulphate solution to remove the bromine, dehydrated with sodium sulphate, and distilled to eliminate the ether. The residue was treated with cold petroleum ether which precipitated a mixture of linolic tetrabromides. The crude solid tetrabromides were separated from the oily (gamma) tetrabromide and oily oleic dibromide by filtering. The crude crystalline tetrabromides were washed with petroleum ether, after which they were crystallized from ethyl alcohol (95 per cent). Two crops of impure alpha linolic tetrabromide (melting point 110 to 113° C.) were obtained. The crude alpha tetrabromide was washed again with petroleum ether and crystallized once from gasoline and several times from ethyl alcohol. After this further purification the melting point was 112.3 to 114.3° C.

[5] West, A. P., and F. L. Smith, 2d, Bull. P. I. Bur. Forestry 24 (1923).
[6] West, A. P., and Z. Montes, Philip. Journ. Sci. 18 (1921) 619.
[7] Philip. Journ. Sci. 32 (1927) 41–52.
[8] Dunlap, F. L., Journ. Am. Chem. Soc. 28 (1906) 397.
[9] Philip. Journ. Sci. 31 (1926) 441.

Salts of alpha linolic tetrabromide were prepared by first converting the acid into the potassium salt. An alcoholic solution of the potassium salt was then treated with a solution of an inorganic salt, such as zinc chloride. The precipitated salt thus obtained was purified and the melting point and solubility in various solvents were determined. The sodium and potassium salts were, however, prepared directly from the free alpha linolic tetrabromide. In preparing these salts ethyl alcohol (95 per cent) was used as a general solvent.

Potassium salt of alpha linolic tetrabromide.—Thirty-five grams of alpha linolic tetrabromide were dissolved in about 600 cubic centimeters of hot ethyl alcohol (95 per cent). To this alcoholic solution there was added from a burette an excess of the calculated amount of half normal alcoholic potassium hydroxide solution prepared with aldehyde-free alcohol. The potassium salt of the alpha linolic tetrabromide was formed as a white, gelatinous precipitate which dissolved when the mixture was boiled. The mixture was heated (reflux) on a water bath for about five hours. When the mixture was cooled the potassium salt separated out and was removed by filtering. The potassium salt was crystallized once from methyl alcohol and once from ethyl alcohol. It was then placed on a watch glass and dried in a vacuum desiccator.

Analysis:

	Bromine. Per cent.
Calculated for $C_{18}H_{31}Br_4O_2K$	50.10
Found	50.13

Zinc salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in about 200 cubic centimeters of hot ethyl alcohol (95 per cent). To the hot clear solution was added with shaking a slight excess of the calculated amount of half normal alcoholic potassium hydroxide solution. The mixture was heated (reflux) on a water bath for about two hours and then treated with a slight excess of the calculated quantity of hot alcoholic zinc chloride solution (0.9287 gram of zince chloride dissolved in 150 cubic centimeters of ethyl alcohol). A white flocculent precipitate of the zinc salt of alpha linolic tetrabromide was formed. The mixture was heated (reflux) on a water bath until the alcohol above the precipitate was completely clear indicating that the reaction was complete. This required about seven hours. The mixture was cooled and filtered. The precipitate was washed several times with ethyl alcohol to remove any unchanged alpha linolic tetrabromide, and with ethyl alcohol (50 per cent) until the

washings gave a negative test for chlorides. After washing again with a small quantity of ethyl alcohol (95 per cent) the product was dried in an oven at 60° C. and then placed in a vacuum desiccator.

The melting point determination showed that the salt began to melt at 154.7° C. and melted completely at 158.8° C. without turning brown.

The formula of the salt was checked by determining the zinc as zinc oxide. A weighed quantity of the salt, placed in a porcelain crucible, was treated with a few drops of concentrated sulphuric acid and heated gently. After ignition with a Bunsen flame the zinc was weighed as zinc oxide.

Analysis:

	Zinc. Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Zn$	5.17
Found	5.31

Calcium salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in 200 cubic centimeters of hot ethyl alcohol (95 per cent) and to this hot solution 27.5 cubic centimeters of alcoholic potassium hydroxide solution (1 cubic centimeter = 0.02873 gram potassium hydroxide) containing a very slight excess of the calculated amount of potassium hydroxide were added with vigorous shaking. The mixture was heated (reflux) on a water bath for about two hours. The solution of the potassium salt was then treated with an alcoholic solution of calcium bromide (1.5 grams $CaBr_2$ dissolved in 125 cubic centimeters of ethyl alcohol) containing a very slight excess of the calculated amount of calcium bromide. The calcium salt of alpha linolic tetrabromide was precipitated. When the mixture was boiled (reflux) on a water bath the liquid above the precipitate became perfectly clear. The boiling was continued for about four hours to insure the completion of the reaction. The mixture was then cooled and the calcium salt removed by filtering, after which it was washed with ethyl alcohol (50 per cent) until the washing gave a negative test with silver nitrate which indicated that no potassium or calcium bromides were present as impurities. The calcium salt was then washed with hot ethyl alcohol (95 per cent) to remove any unchanged alpha linolic tetrabromide. The salt was then dried in a vacuum desiccator.

When the melting point was determined, the salt began to turn brown at 208.7° C. and melted completely at 213.4° C. with decomposition.

In order to check the formula a weighed quantity of the salt was treated with sulphuric acid and the calcium determined as calcium sulphate.

Analysis:

	Calcium. Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Ca$	3.24
Found	3.03

Strontium salt of alpha linolic tetrabromide.—The strontium salt of alpha linolic tetrabromide was prepared by mixing a hot solution of 8 grams of the tetrabromide dissolved in 200 cubic centimeters of ethyl alcohol (95 per cent) with a slight excess of half normal alcoholic potassium hydroxide. The mixture was heated (reflux) on a water bath for about three hours and then treated with a hot alcoholic solution of strontium bromide which was prepared by dissolving 2.7 grams of crystallized strontium bromide ($SrBr_2.6H_2O$) in 50 cubic centimeters of ethyl alcohol. The mixture was diluted with hot ethyl alcohol to a volume of about 1,200 cubic centimeters and heated (reflux) on a water bath until the liquid above the precipitate was perfectly clear, indicating that the reaction was complete. This required about ten hours. As a portion of the alcohol evaporated while the mixture was boiling, small quantities of alcohol were added occasionally to replace the loss.

The mixture was then cooled to room temperature and the strontium salt removed by filtering. The strontium salt was washed with ethyl alcohol (50 per cent) until free from bromides, as determined by the silver nitrate test. The salt was next washed with hot ethyl alcohol (95 per cent) to eliminate any unchanged tetrabromide and dried in a vaccuum desiccator.

The melting point determination showed that the salt began to turn brown at 200.4° C. and melted completely at 206° C. with decomposition.

The formula was checked by treating a portion of the salt with sulphuric acid and determining the strontium as sulphate.

Analysis:

	Strontium. Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Sr$	6.81
Found	6.52

Barium salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in about 200 cubic centimeters of ethyl alcohol. The solution was treated with a slight excess of the calculated amount of half normal alcoholic

potassium hydroxide solution and heated (reflux) on a water bath for about one and a half hours. A solution of barium bromide was prepared by treating 2.36 grams of crystallized barium bromide ($BaBr_2.2H_2O$) with 5 cubic centimeters of water and 100 cubic centimeters of hot ethyl alcohol. The hot clear solution of barium bromide was added to the alcoholic solution of the potassium salt previously prepared. The mixture was diluted with about 150 cubic centimeters of ethyl alcohol and heated (reflux) on a water bath until the liquid above the precipitate was entirely clear. This required about six hours. Small quantities of ethyl alcohol were added from time to time to replace the alcohol lost by volatilization.

The mixture was then allowed to cool and was filtered. The barium salt was then washed with ethyl alcohol (50 per cent) until free from bromides as indicated by the silver nitrate test. The salt was next washed with hot ethyl alcohol (95 per cent) to remove any linolic tetrabromide and dried in a vacuum desiccator.

A determination of the melting point showed that the salt began to turn brown at 196.3° C., and melted completely at 202.5° C. with decomposition.

The salt was analyzed for barium by treating a portion with sulphuric acid and determining the barium as sulphate.

Analysis:

	Barium. Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Ba$	10.29
Found	9.87

Sodium salt of alpha linolic tetrabromide.—Twenty grams of alpha linolic tetrabromide were dissolved in 600 cubic centimeters of hot ethyl alcohol. The solution was treated with 70.5 cubic centimeters of alcoholic sodium hydroxide solution (1 cubic centimeter = 0.02943 gram sodium hydroxide). The mixture was heated (reflux) on a water bath for about three hours to eliminate the turbidity and then poured into a beaker, diluted with about 100 cubic centimeters of ethyl alcohol, and cooled. The gelatinous sodium salt was removed by filtering and washed with ethyl alcohol. The salt was then recrystallized from hot ethyl alcohol (95 per cent) and dried in a vacuum desiccator. The sodium salt is considerably more soluble in ethyl alcohol than are the other salts that were prepared. The filtrate and washings from the first crop were concentrated to about a fourth of the original volume and a second yield was obtained.

The melting point determination showed that the salt began to turn brown at 194.2° C., and melted completely at 201.1° C. with decomposition.

The percentage of sodium was determined by converting a portion of the salt into sodium sulphate.

Analysis:

	Sodium. Per cent.
Calculated for $C_{18}H_{32}Br_4O_2Na$	3.69
Found	3.28

Melting point.—A determination of the melting point of the salts that were prepared showed that most of them decomposed when heated to a sufficiently high temperature. This is not unusual since, according to the literature,[10] a number of salts of long-chain aliphatic acids do not give a sharp melting point.

Solubility.—Qualitative solubility experiments on the salts that were prepared were made at room temperature (about 30° C. and designated as cold), and also in hot solvents. For low-boiling solvents, like acetone, the solubility in hot solution was determined at the boiling temperature of the solvent. With high-boiling solvents, such as benzyl alcohol, the temperature for solubility determination was about 90° C. In reporting the qualitative solubility data, the term "soluble" is used for solvents which dissolve the salt to the extent of about 1 to 4 per cent. For solubility below 1 per cent the terms "insoluble" or "slightly soluble" are used. The term "very soluble" is used when about 5 per cent or more of the salt is dissolved.

As shown by the solubility data given in Table 1, the salts of alpha linolic tetrabromide, prepared in this research, are not very soluble in the ordinary organic solvents. Experiments showed that 100 cubic centimeters of hot ethyl alcohol dissolved about 5.4 grams of the sodium salt and 1.5 grams of the potassium salt. One hundred cubic centimeters of hot methyl alcohol dissolved about 12 grams of the sodium salt and 2.5 grams of the potassium salt. One hundred cubic centimeters of warm benzyl alcohol dissolved about 2 grams of the sodium salt and 13.6 grams of the potassium salt. One hundred cubic centimeters of warm normal propyl alcohol dissolved about 6.7 grams of the sodium salt and 14.5 grams of the potassium salt. One hundred cubic centimeters of ethyl

[10] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 156, 157, 160, 163, 172, 175, 191, 192, 200, 240, 207. Beilstein's Handbuch der Organischen Chemie, Vierte Auflage, 2 (1920) 361, 369, 372, 374, 395, 396, 466, 473.

benzoate dissolved about 11.7 grams of the zinc salt, 9 grams of the barium salt, 7 grams of the calcium salt, and 8.6 grams of the strontium salt.

TABLE 1.—*Solubility of salts of alpha linolic tetrabromide.*

[I, insoluble; ss, slightly soluble; S, soluble; VS, very soluble.]

Solvent.	Sodium salt.		Potassium salt.		Zinc salt.		Barium salt.		Calcium salt.		Strontium salt.	
	Cold.	Hot	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.
Acetone	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Amyl alcohol	I	I	I	I	I	I	I	I	I	I	I	I
Benzene	ss	ss	ss	ss	I	ss	I	ss	I	ss	I	ss
Benzyl alcohol	ss	S	ss	VS	I	ss	I	ss	I	ss	I	ss
Chloroform	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Carbon tetrachloride	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Ether	I	ss	I	ss	I	I	I	I	I	I	I	I
Ethyl alcohol	ss	VS	ss	S	ss	ss	ss	ss	ss	ss	ss	ss
Ethyl acetate	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Ethyl benzoate	ss	ss	ss	ss	ss	VS	ss	VS	ss	VS	ss	VS
Ethyl bromide	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Isopropyl alcohol	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss
Methyl alcohol	ss	VS	ss	S	ss	ss	ss	ss	ss	ss	ss	ss
Propyl alcohol (n)	ss	VS	ss	VS	ss	ss	ss	ss	ss	ss	ss	ss
Petroleum ether	I	ss	I	ss	I	ss	I	ss	I	ss	I	ss
Toluene	I	I	I	I	I	I	I	I	I	I	I	I
Xylene	I	ss	I	ss	I	ss	I	ss	I	ss	I	ss

These solubility experiments indicate that ethyl, methyl, and normal propyl alcohols are good solvents for the sodium salt; benzyl and normal propyl alcohols are good solvents for the potassium salt; ethyl benzoate appears to be the best solvent for the zinc, barium, calcium, and strontium salts.

SUMMARY

Alpha linolic tetrabromide (melting point, 112.3 to 114.3° C.) was prepared from lumbang oil.

The sodium and potassium salts of alpha linolic tetrabromide were prepared by treating an alcoholic solution of the free acid with an alcoholic solution of the corresponding alkali.

From the potassium salt of alpha linolic tetrabromide the zinc, barium, calcium, and strontium salts were prepared.

The melting point of these compounds was determined and the formulas were checked by analysis.

The solubility of the sodium, potassium, zinc, barium, calcium, and strontium salts of alpha linolic tetrabromide was determined for various solvents.

COMPOSITION AND COMPARATIVE SERVICE VALUE UNDER PHILIPPINE CONDITIONS OF SOME IMPORTED PREPARED PAINTS

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SEVEN PLATES

Recently a marked tendency has been observed among paint consumers in the Philippine Islands to use prepared paints, already mixed for application. Possibly, the main factors that have contributed to this situation are the ever-increasing difficulty of securing the services of skilled painters capable of properly mixing different paints and colors, and the relatively low price of the ready-mixed products.

Prior to American occupation and some years since, Great Britain practically monopolized the exportation of paints and paint materials to the Islands. The English paints are generally imported in the form of paste, and on the average are of good quality. Foremost among the well-known brands is Hubbuck. Until very recently, master painters of long experience could not be induced to accept any other brand, in spite of the fact that American paints of similar grade and quality were being offered in the local market. The superiority of Hubbuck became more apparent when, in the period 1917 to 1919, the increased demand for paint and paint materials attracted the attention of unscrupulous dealers who, encouraged by the high prices then prevailing, flooded the market with all sorts of paints of inferior class, the greater proportion of which were of the "Ready Mixed" variety. Of course, the unsatisfactory results soon became evident, and the consumer felt that these results justified his former doubts of the service value of all unknown brands of paints and paint materials, irrespective of their physical and chemical characters.

In this connection, the statistics on the comparative importation of paints from the United States and the United Kingdom, those two countries supplying the bulk of this material consumed in the Philippines, taken from the Statistical Bulletin of the

Bureau of Commerce and Industry, 1919, 1922, and 1924, are of interest. The figures show that, while the imports from the United States increased 233 per cent from 1917 to 1919, those from the United Kingdom increased 3 per cent only. On the other hand, imports from the United States from 1919 to 1922 decreased 61 per cent, while those from Great Britain increased 51 per cent. The unsatisfactory results obtained from the use of paints of inferior quality, imported during the prosperous years 1917 to 1919, in all probability were the cause of the drop from 1919 to 1922, in the imports from the United States, whence the bulk of the prepared paints come. To obtain reliable results the consumer had to return to the use of the well-known brands of paint imported from the United Kingdom.

However, from 1922 on a steady increase in the imports from the United States has been observed. The change seems to indicate that the good qualities of high-grade American paints are beginning to be appreciated by the intelligent consumer, and these paints are fast gaining a foothold in the Philippine market.

PREVIOUS WORK ON THE SUBJECT

I know of no published data on the actual service value of paints under local conditions. The Bureau of Public Works, the Bureau of Supply, the various paint importers and, very recently, a local paint manufacturer have been doing some work along this line. Apparently the data so obtained are kept for the information of the interested parties and are not intended for publication.

OBJECT OF THE PRESENT ARTICLE

This article deals with the results of exposure tests, under Philippine conditions, mainly of imported prepared paints submitted for analysis to the Bureau of Science by the Bureau of Supply, the Bureau of Public Works, and paint agents in connection with Government bids.

Our experience with the service value of a large number of these prepared paints has been very discouraging. Paints which were sold at a good price, on the strength of the claim of the manufacturers and their agents that they have given satisfactory service in temperate countries, have shown very poor weather-resisting properties under Philippine conditions. Some of the paints were even advertised to be especially prepared for use in the Tropics.

It is for the purpose of ascertaining the relationship existing between the chemical analysis and the service value of these paints, under local climatic conditions, that this work has been undertaken.

The importance of the knowledge of local conditions and their relation to the composition of the paint has long been recognized by Chessman.[1] He makes the following statement:

> The Manufacturer should also know the condition under which his paint is to be used, otherwise perfect results in some locations, will prove a failure elsewhere.

Other factors, which cannot be disregarded without seriously affecting the life of the paint, are atmospheric conditions at the time of painting, kind and condition of the painted surface, manner of application, and many other more or less important details that have a direct bearing on the endurance and wearing qualities of the paint films.

SCOPE OF THE WORK

The work can be divided into two general stages; namely, chemical analyses and exposure tests. The chemical analyses embrace the separation of the vehicle from the pigment, the analysis of the vehicle, and the analysis of the pigment. The exposure tests embrace the preparation of the surface to be painted, the application and the drying of the paint, and the exposure of the painted surface after the paint film is thoroughly dry.

METHODS OF PROCEDURE

The analyses of the vehicle and the pigment followed mainly Holley's methods of procedure,[2] supplemented by Griffin's methods.[3] It was also found convenient to follow electro-analytical methods [4] in the determinations of lead and of zinc.

In the preparation and exposure of the panels, the general methods described by Gardner [5] were followed; namely, painting

[1] The Review of Technical Paints, Williamsport, Pa., Chessman and Elliot (1911) 10.

[2] Analysis of Paints and Varnish Products, New York, John Wiley and Sons (1912).

[3] Griffin, R. C., Technical Methods of Analysis, New York, McGraw-Hill Co., Inc. (1921) 193–279.

[4] Smith, E. F., Electro-Analysis, 4th ed., Philadelphia, P. Blakiston's Son & Co. (1907) 100 and 109.

[5] Paint Technology and Tests, New York, McGraw-Hill Book Co. (1911) 105.

the panels within the building so that each class of paint might be subjected to fairly equal conditions of application and drying, determination of the spreading rate, and the general arrangement of the panels in the framework of the test fence.

The panels used were of two kinds; namely, iron panels 61 by 40 centimeters and wooden panels 61 by 30 centimeters.

The iron panels were 4 millimeters thick; before use they were cleaned by pickling in 10 per cent sulphuric acid, washed in water and then in a 10 per cent solution of caustic soda, and washed again with plenty of water. Afterward they were wiped with a dry cloth. Any rust spots formed while drying, which apparently is difficult to avoid, were sandpapered. Before the application of the paint the surface was polished to a metallic luster. The wooden panels were white lauan boards, 1 inch thick, and were well planed and smoothed before they were painted.

Two coats of paint were applied to each panel; the first coat was thoroughly dry before the second coat was applied. Although the panels were not painted during any particular season of the year (some were painted whenever a sample of paint was received in the Bureau of Science), the average condition within the building, at about the same hour of the day, was practically uniform as far as temperature and humidity are concerned. Therefore, it can be stated that the paints were applied under practically the same average local indoor conditions.

Inspection of the painted surfaces was made every three months. Note was made of any changes in the appearance of the paint films, such as degree of discoloration, cracking or checking, chalking and wearing out of paint and, in the case of the iron panels, the quantity of rust developed.

LOCATION OF THE TEST FENCES

The test fences shown in Plate 1, figs. 1 and 2, were built on the roof of the Bureau of Science, which is about 10 meters above the ground. The location is higher than many of the buildings in the neighborhood and the surrounding trees. Outside influences other than those of changes in the local atmospheric condition were thus eliminated as much as possible. The longer fence, fig. 1, runs north and south, while the shorter fences, fig. 2, run east and west. The panels were arranged in a vertical position. Each sample of paint was applied on two panels; one of the panels was placed on the north-south fence, and the other on one of the east-west fences. The panels placed

on the north-south fence were exposed to the winds blowing from east and west as well as to the direct and more-severe action of the sun rays. The serial numbers of these panels carry the letter A. The panels placed on the east-west fences were exposed to the north and south winds and did not receive directly the action of the sun rays. The serial numbers of these panels carry the letter B. By means of these arrangements the comparative weathering action on the paint films of atmospheric elements from the four main geographical directions could be better appraised.

GENERAL CHARACTERISTICS OF THE PAINTS

The greater number of the paints tested were of the mixed variety, prepared for application.

One sample, painted on panel 1, carried instructions on its label giving quantities of oil and of thinner to be added to the paint, when applied as first coat, second coat, and final coat. Another sample was a little too thick for immediate application and had to be thinned with small amounts of oil and turpentine.

Some white paint pastes (painted on panels 13, 14, 15, 16, and 28) were also received. A sufficient quantity of linseed oil and a small amount of turpentine were incorporated with the pastes until they attained a good flowing consistency and could be worked easily with the brush. Four of these pastes were combinations of two or more pigments ground in linseed oil, and one consisted of only one pigment.

The greater proportion of the pigments composing the red and the green paints were inert materials, the barytes predominating. Some specimens were mixtures of color and whiting, representing perhaps the cheapest variety of imported paints.

Four samples of bituminous paints were also tested. These paints are mainly composed of asphalt dissolved in petroleum oils or resin oils, or a mixture of both and mineral colors. The solvents consist of oils of different boiling points, and the more volatile of these possesses a strong penetrating odor which seems to persist for several hours. For this reason these paints should not be used for interior work or in places where ventilation is poor.

TABULATED RESULTS OF CHEMICAL ANALYSES AND SERVICE TESTS

Tables 1 to 4 represent condensed reports of the chemical composition of the paints and their service value under local conditions.

Tables 1 and 2 are composed of six sections; Table 3 gives data for bituminous paints, and Table 4 for white paste paints.

Under the first and the second sections, the compositions of the paint and the vehicle, respectively, are tabulated. The figures given under these sections should not be considered as representing accurate quantities of different ingredients used by the manufacturer. No method of extraction will absolutely remove all the vehicle from the pigment,[6] the insoluble portion being possibly metallic soap or linoxin.[7] In the determination of the volatile oils, either by steam distillation or hot air-bath, appreciable quantities are lost. The results obtained by the air-bath method are usually lower than those obtained by steam distillation;[6] on the other hand, by the latter method water-soluble volatile liquids are lost. Similar difficulties are encountered in the determination of water in paints. As to the determination of resinous gums, none of the known methods is absolutely reliable.

Figures given under section 3 are the results of separate chemical determinations of the basic and acid radicals from which the probable composition of the pigment under section 4 is computed. Holley[8] gives the chemical analyses of various commercial paint products. By comparing these analyses with the results under section 3, the different constituents were grouped together to represent well-known commercial pigments such as ochers, barytes, whitings, silicates, kaolins, and reds.

The names of colors adopted under section 5[9] are descriptive, and furnish some idea of the difference in the intensity of the shades of paints of the same color. The data on the painted panels and the condensed remarks on the results of exposure tests are self-explanatory.

GENERAL OBSERVATIONS ON THE RESULTS OF THE TESTS

Before discussing the general behavior of paints under local conditions, it was thought convenient to furnish a short description of the prevailing weather in Manila during the year.

[6] Bottler, Max, and A. H. Sabin, German Varnish Making, New York, John Wiley and Sons (1912) 282.

[7] Gardner, H. A., Physical and Chemical Examination of Paints, Varnishes and Colors, 2d ed., Institute of Paint and Varnish Research, Washington, D. C. (1925) 214.

[8] Analysis of Paints and Varnish Products, New York, John Wiley and Sons (1912) 84, 85, 90, 179, 181.

[9] By comparison with the color plates in Robert Ridgway's Color Standards and Color Nomenclature, Washington, D. C. (1912).

TABLE 1.—*Condensed report on the composition and service value of some specimens of red paints.*

[Results are expressed in percentage by weight.]

Panel No.	Composition of paint.		Composition of vehicle.			Analysis of pigment.									
	Vehicle.	Pigment.	Volatile thinner.	Linseed oil.	Resinous gums.	Lead oxide (PbO).	Zinc oxide (ZnO).	Silica (SiO_2).	Ferric oxide (Fe_2O_3).	Aluminium oxide (Al_2O_3).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Sulphuric acid anhydride (SO_3).	Carbonic acid anhydride (CO_2).	Combined water and undetermined.
1	43.2	56.8	[b] 4.1	95.9	.....	36.04	21.44	10.96	4.47	3.04	5.99	9.35	6.02	.....	2.99
2B	60.5	39.5	[d] 20	[d] 49.4	[d] 30.6	- -----	.....	37.80	14.10	0.57	15.28	17.80	6.35	.....	8.10
4B	57.3	42.7	43	44	13	.....	.....	12.78	7.07	18.15	33.56	0.52	7.18	20.74	.....
8A	70	30	[b] 7	[e] 90	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	77.9	22.1	43	[e] 57	.....	.....	.....	22.19	49.85	18.76	1.85	.....	.....	.....	7.35

Panel No.	Probable composition of pigment.								
	Basic lead sulphate.	Zinc oxide.	Lead chromate.	Baryte.	Whiting.	Ocher.	Silicates.	Kaolin.	Indian red.
1	42.06	21.54	.....	.....	.....	36.40	.....	.....	.....
2B	.....	.....	.....	.....	.....	44.30	55.70	.....	.....
4B	.....	.....	.....	.....	46.14	53.86	.....	.....	.....
8A	.....	.....	7	34	.....	.....	.....	40	19
17	.....	.....	.....	.....	.....	.....	.....	50.15	49.85

[b] Turpentine.

[d] Analysis by Ramon Feliciano, chemist, Bureau of Science.

[e] Lumbang oil.

TABLE 1.—*Condensed report on the composition and service value of some specimens of red paints*—Continued.

Panel No.	Color.[a]	Surface painted.	Approximate covering capacity, grams per square meter.		Protective qualities.	Fastness of color.	Approximate life of paint in months.	Cause of decay.	Condition for repainting.
			First coat.	Second coat.					
1	Mikado brown	Wood	110	[c] 100	Good	Poor	36	Gradual wearing qut	Good.
2B	Brick red	Iron	40	23	Very poor	do	6	"Alligatoring" and peeling	Bad.
4B	Hessian brown	do	53	40	do	do	5	Small checks and disintegration	Do.
8A	Blackish brown	do	38	40	Fair	Fair	22	Wearing out of film	Fair.
17	Warm blackish brown	do	46	78	do	do	18	do	Do.

[a] Obtained by comparison with Robert Ridgway's Color Standards and Color Nomenclature, Washington, D. C. (1912).

[c] 97 grams per square meter for the third coat.

TABLE 2.—*Condensed report on the composition and service value of some specimens of green paints.*

[Results are expressed in percentage by weight.]

Panel No.	Composition of paint.		Composition of vehicle.				Analysis of pigment.								
	Vehicle.	Pigment.	Volatile thinner.	Linseed oil.	Resinous gums.	Water.	Lead oxide (PbO).	Zinc oxide (ZnO).	Chromic oxide (CrO_3).	Silica (SiO_2).	Ferric and aluminium oxides (R_2O_3).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Sulphuric acid anhydride (SO_3).	Carbonic acid anhydride (CO_2).
5A	81.9	18.1	[b] 51	37	12		14.42		6.47	10.24	21.25	15.52	0.88		13.20
6A	67.4	32.6		100			12.22		5.49	26.95	20.87				
7	50	50	[c] 10	90											
18A	39.8	60.2	14.7	73.3	12		3.38		1.52	0.86	3.26	40.91	5.32		37.93
19A	38.5	61.5	36	57.5	6.5		3.51		1.24	6.62	5.87	0.14	2.69	0.20	
20A	48.4	51.6	36.5	51	2.2	10.3	6.11		2.75	10.16	7.42	6.64	2.58	0.91	
[d] 21	73.6	26.4	33.7	63.2	3.1		17.80	15.76	4.84	3.21	5.87	2.58	2.85	2.53	
[d] 22	38.3	61.7	15.6	74.9		9.5	13.25		5.96	3.54	6.77	0.70	3.24	1	
23	41.8	58.2	26.3	49.3		24.4	3.57		1.60	3.63	4.57	47.20	0.29		37.34
24	44.9	55.1	7.5	80.5		12	7.25		3.20	0.36	4.74	23.10			18.04
25	65.7	34.3	27.9	54.5	11.7	5.9	10.20		4.60	10.31	18.85	2.02	3.70	2.84	
[f] 26A	60.9	39.1	25.7	46.1		28.2	6.21		2.80	5.66	5.69	19.50	0.57		15.93
[g] 27	51.6	48.4	38.7	58.4	2.9		7.28		3.25	8.40	6.61		3.58		

[b] Twenty-five per cent distills off above 150° C.

[c] Turpentine.

[d] Enamel paint.

[e] About 6 per cent additional oil was incorporated with the paint.

[f] Red-lead paint was used in the priming coat.

[g] Analysis made by Jose C. Espinosa, chemist, Bureau of Science.

TABLE 2.—*Condensed report on the composition and service value of some specimens of green paints*—Continued.

Panel No.	Analysis of pigment.				Probable composition of pigment.								
	Cyanogen (CN).	Carbon (C).	Barium sulphate ($BaSO_4$).	Combined water and undetermined.	Zinc oxide.	Chrome yellow.	Prussian blue.	Baryte.	Ocher.	Silicates.	Whiting.	Carbon, amorphous.	Carbon, graphitic.
5A	0.78	17.24				20.89	2.41		29.86		29.60	17.24	
6A	2.22	32.25				17.71	6.82		43.22			16.83	15.42
7					4	12.50	7.50	66		10			
18A	1.30		4.14	1.38		4.90	3.96	4.14			87		
19A	1.15		76.99	1.59		4.75	3.55	77.33		14.37			
20A	1.17		62.26			8.86	3.61	63.81		23.72			
[d] 21	2.23		41.50	0.83	15.76	25.17	6.88	41.50		10.69			
[e] 22	1.64		62.23	1.67		19.21	5.03	63.93		11.83			
23	1.26			0.54		5.17	3.87		6.13		84.83		
24	1.72		40.81	0.78		10.50	5.29	40.81			43.40		
25	0.17		43.25	4.06		14.80	0.51	48.11	36.58				
[f] 26A	2.23		41.18	0.23		9.01	6.70	41.18	7.11		36		
[g] 27	1.19		69.50	0.19		10.53	3.68	69.50	16.29				

TABLE 2.—*Condensed report on the composition and service value of some specimens of green paints*—Continued.

Panel No.	Color.[a]	Surface painted.	Approximate covering capacity, grams per square meter.		Protective qualities.	Fastness of color.	Approximate life of paint in months.	Cause of decay.	Condition for repainting.
			First coat.	Second coat.					
5A	Olivaceous black	Iron	44	26	Very poor	Poor	5	Weak porous film	Bad.
6A	Greenish black	do	43	27	Good	Good	30	Chalking and wearing off	Good.
7	Dusky olive green	do	47	49	Fair	Poor	16	do	Do.
18A	Light Danube green	do	79	127	Very poor	do	5	Checks and peeling off	Bad.
19A	do	do	42	92	Poor	do	12	Chalking and disintegration	Fair.
20A	Danube green	do	49	118	Very poor	do	3	"Alligatoring"	Bad.
[d] 21	Chromium green	do	76	56	do	Very poor	3	Porous film; rust eruptions	Do.
[e] 22	Blackish green	Wood	116	145	Fair	Fair	24	Slow wear	Good.
23	Varley's green	do	183	162	Poor	Poor	6	Small checks	Bad.
24	Danube green	do	130	195	Good	Fair	32	Chalking and falling off	Fair.
25	Dark ivy green	do	113	154	do	do	29	Chalking and wearing off	Good.
[f] 26A	Antique green	Iron	[h] 118	[i] 78	Very good	do	31	Decomposition of carbonate pigment	Do.
[g] 27	Cossack green	Wood	103	113	Very poor	Poor	3	Checks all over surface	Bad.

[a] Obtained by comparison with Robert Ridgway's Color Standards and Color Nomenclature, Washington, D. C. (1912).
[d] Enamel paint.
[e] About 6 per cent additional oil was incorporated with the paint.
[f] Red-lead paint was used in the priming coat.
[g] Analysis made by Jose C. Espinosa, chemist, Bureau of Science.
[h] Weight of red-lead paint used as priming coat.
[i] Weight of the green paint.

TABLE 3.—*Condensed report on the composition and service value of some specimens of bituminous paints.*

[Results are expressed in percentages.]

Panel No.	Estimated composition of paint (by weight).			Estimated composition of volatile vehicle (by volume).		Probable composition of pigment (by weight).							
	Volatile vehicle.	Nonvolatile vehicle.	Pigment.	Petroleum oils.	Resinous oils.	Ultramarine blue.	Prussian blue.	Chrome yellow.	Titanic oxide.	Red oxide.	Ocher.	Baryte.	Silicates.
9A	41.1	25.4	33.5		100	25			18.9			56.1	
10A	58.6	25.4	16	80	20					80.1			19.9
11A	52.2	27.9	19.9	5	95		12.5	22.4	5.8		12.1	47.2	
12A	67	31.6	[b] 1.4	80	20								100

Panel No.	Color.[a]	Surface painted.	Approximate covering capacity, grams per square meter.		Protective qualities.	Fastness of color.	Approximate life of paint in months.	Cause of decay.	Condition for repainting.
			First coat.	Second coat.					
9A	Grayish olive	Iron	230	229	Very poor	Very poor	3	Rust eruption and disintegration	Bad.
10A	Hessian brown	do	157	112	Poor	Fair	5	do	Poor.
11A	Dusky yellowish green	do	127	121	Very poor	Poor	3	do	Do.
12A	Black	do	115	172	Poor	Fair	6	do	Do.

[a] Obtained by comparison with Robert Ridgway's Color Standards and Color Nomenclature, Washington, D. C. (1912).

[b] Ash.

TABLE 4.—*Condensed report on the composition and service value of some specimens of white paste paints.*

[Results are expressed in percentages by weight.]

Panel No.	Composition of paint.		Composition of vehicle.		Analysis of pigment.									
	Vehicle.	Pigment.	Volatile thinner.	Linseed oil.	Lead oxide (PbO).	Zinc oxide (ZnO).	Silica (SiO_2)	Aluminium oxide (Al_2O_3).	Calcium oxide (CaO).	Magnesium oxide (MgO).	Sulphuric acid anhydride (SO_3).	Carbonic acid anhydride (CO_2).	Barium sulphate ($BaSO_4$).	Combined water and undetermined.
[a]13B	40	60	22.5	77.5	11.86	46.03	21.60	4.48	2.77	5.43	4.24	----	----	3.59
14B	8.5	91.5	----	100	27.76	29.28	----	----	----	----	----	3.65	37.96	1.35
15B	7.5	92.5	----	100	43.01	----	----	----	----	----	----	5.80	47.81	3.38
16B	16.4	83.6	----	100	----	99.06	----	----	----	----	----	----	----	0.94
28	5.1	94.9	----	100	12.70	26.70	5.60	4.72	----	----	----	1.67	48.28	0.33

Panel No.	Probable composition of pigment.					Surface painted.	Protective qualities.	Discoloration.	Approximate life of paint in months.	Cause of decay.	Condition for repainting.
	White lead (carbonate).	White lead (sulphate).	Zinc oxide.	Baryte.	Silicates.						
[a]13B	----	16.10	46.03	----	37.87	Wood	Very good	None	40	Slow wear	Very good.
14B	32.14	----	29.28	38.58	----	do	Good	do	35	Scaling and disintegration	Fair.
15B	51.10	----	----	48.90	----	do	Poor	Slight	10	Rapid wear	Good.
16B	----	----	99.06	----	----	do	Very good	None	37	Slow wear	Very good.
28	14.70	----	26.70	48.28	10.32	do	Fair	do	30	Localized checks	Fair.

[a] Ready prepared paint.

The year can be divided into two distinct seasons; namely, the dry season and the rainy season. The dry season generally begins in the month of December and lasts until May, while the rainy season starts in May and lasts until the month of December. In the dry season the prevailing winds are the north northeast and the east southeast, and in the rainy season the south southwest and the west northwest. The mean maximum temperature in the months of June, July, and August is about 31.5° C. (mean during the year, 26° C.). It is during these months that typhoons are frequent and the rainfall heavy. The average daily velocity of the wind during these three months is over 300 kilometers (mean for the year, 200 kilometers) and the average monthly rainfall is over 450 millimeters (mean for the year, 180 millimeters). The figures given were taken from the Annual Report of the Weather Bureau for 1920. Deviation from these figures from year to year is slight.

From the foregoing the following general observations on the results of tests are apparent. The paint films were less affected by the weather in the dry season than in the rainy season. In the rainy season, especially in the months of June, July, and August, marked and rapid changes were observed in the general appearance of the paint coats. Discoloration, disintegration, checking, chalking, etc., appeared at this period of the year. The south and west side portions of the panels showed a more weather-beaten condition than did the north and the east side portions. Earlier failures, due to the action of typhoons, were also observed on all paint coats exposed to the west.

It was also apparent that very few of the red and the green paints offered a fair degree of resistance to discoloration, due probably to the combined action of the rain and the moist heat of the tropical sunshine prevailing during the months of June, July, and August. The energetic action of ultra-violet rays on certain types of paint, causing disintegration and bleaching out of colors, is a known fact.[10] That tropical sunshine is richer in ultra-violet rays than is the sunshine in the temperate regions was demonstrated by Bacon [11] in 1910. Permanency of colors, therefore, is one of the most important properties to be considered in the preparation of paints for tropical countries.

[10] Gardner, A. H., Paint Technology and Tests, New York, McGraw-Hill Book Co. (1911) 112.

[11] Philip. Journ. Sci. § A 5 (1910) 269.

REMARKS ON THE SERVICE VALUE OF THE DIFFERENT PAINTS

PAINTS FOR IRON SURFACES

Red-lead paint used as primer for iron surfaces is excellent. Panel 26A, Table 2, Plate 2, fig. 1, was given a priming coat of red lead paint on which a second coat of a cheap green paint was applied. The results are very satisfactory. The green paint alone, without the priming coat of red lead would have failed within a few months; it is one of the cheapest varieties of imported prepared paints. More-expensive paints, such as those painted on panels 20 and 21, Table 2, failed within three months. These results agree with Gardner's [12] statement that practically any moisture-excluding paint may be used, whether it be inhibited in action or not, provided the contact coat is inhibitive.

Panel 6A, Table 2, Plate 3, fig. 1, was painted with a graphite paint. From the appearance of the film this paint can be considered the best of the imported ready-mixed metallic paints reported in this paper. It consists of linseed oil, to which no volatile thinner has been added, and pigment in the approximate proportion of 2: 1. The pigment is mainly a mixture of amorphous carbon, graphite, and ocher. It was pointed out by Gardner [13] that carbon, lampblack, and graphite are good conductors of electricity and, therefore, stimulate the formation of rust on the iron surface with which they are in contact. However, Table 2, of the 1910 report of committee U of the American Society for Testing Materials,[14] classifies natural graphite with pigments possessing excellent protective properties. Reid,[15] speaking of paints, mentions the fact that paints containing graphite lasted much longer and had a very great resistance to wetting by water. Rain did not adhere to paint mixed with graphite but ran off. Jennings [16] also stated that graphite paint as a protector of iron had been markedly successful.

The foregoing discrepancies and the results of tests suggest the conclusion that paints containing graphite should not on that account be condemned. Our results, therefore, indicate that graphite paint, properly incorporated with the right quantity of

[12] Paint Technology and Tests, New York, McGraw-Hill Book Co. (1911) 231.

[13] Op. cit. 242.

[14] Op. cit. 236.

[15] Journ. Soc. Chem. Ind. Trans. No. 1, 44 (1925) 31.

[16] Journ. Soc. Chem. Ind. Trans. No. 1, 44 (1925).

oil of good quality, renders as good and satisfactory service as do other paints containing pigments known to posses inhibitive properties.

The paint coat on panel 5A, Table 2, Plate 3, fig. 1, contains about 17 per cent amorphous carbon. The early failure of this paint should be attributed to the high percentage of thinner in the vehicle rather than to its carbon content. The vehicle of this paint contains 51 per cent thinner.

The paints on panels 8A and 7, Tables 1 and 2, were prepared in the Bureau of Science and tested for purposes of comparison. Both paints gave fair results. The oil used for painting panel 7 was commercial boiled linseed oil, and that for painting panel 8 was lumbang oil. The higher proportion of vehicle to pigment in the lumbang-oil paint was due to the somewhat thicker consistency of the oil. After sixteen months of exposure, panel 8 was still in perfect condition, as shown in Plate 2, fig. 2, while this period of time was the approximate life of the paint on panel 7.

The ready-mixed metallic paint applied on panel 17, Table 1, also gave fair results. This paint is lumbang-oil paint, mixed with a very high percentage of volatile mineral thinner, to which the relative early failure of the paint might be attributed. The pigment consists of practically equal proportions of bright iron oxide and clay, both of which possess fairly good protective properties.[17]

This behavior of lumbang oil under actual service test is in line with the findings and conclusions of West and Smith [18] and of Aguilar;[19] namely, that lumbang oil, as a drying oil, is just as good as linseed oil, and either oil can be used as an efficient substitute for the other.

How the different constituents of paints affect their service value is illustrated in Plate 3, fig. 2, showing panels 18A, 19A, and 20A (Table 2). The vehicle of the paint used on panel 18A consists of fairly well-balanced components containing, perhaps, a little more than the correct amount of resinous drier, but the pigment is nearly all whiting, which apparently is subject to rapid decay.[20] The paints coated on panels 19A and 20A are

[17] Gardner, H. A., Bull. Paint Mfrs. Assoc. U. S. A., Scientific Section, 32 (1912).

[18] Bull. P. I. Bur. Forestry 24 (1923).

[19] Philip. Journ. Sci. § A 12 (1917) 235–245.

[20] Bull. Paint Mfrs. Assoc. U. S. A. 32 (1912) 8.

both high in volatile thinners and, therefore, not satisfactory for painting iron surfaces. Excessive volatile thinner, on evaporation, leaves a weak porous film, which furnishes very poor protection to the iron surface. A good contrast between the protective qualities of two paints, one containing a high percentage of volatile thinner and the other containing no volatile thinner, is shown in Plate 3, fig. 1, panels 5A and 6A. The paint applied on panel 19A gave better service than did that applied on panel 20A; the water contained in the latter, used as emulsifier, stimulated the formation of rust. This paint is more especially adapted for use on wooden surfaces.

Panel 2B, Table 1, Plate 4, fig. 1, was painted with a rather expensive paint, well advertised as a metallic paint of superior quality. In less than six months the paint showed unmistakable evidence of failure by "alligatoring." The paint vehicle contains a very high percentage of resinoid drier. According to Smith,[21] excessive resinous drier in a paint injures the wearing properties of that paint, causing it to perish sooner than it should.

Panel 4B, Table 1, Plate 4, fig. 2, was painted with a lower-grade, cheaper metallic paint. The paint vehicle contains an extraordinarily high proportion of volatile thinner, and the pigment consists of whiting and ocher. Rust eruptions were plainly visible in less than five months' time.

In Plate 5, figs. 1, 2, and 3, the condition of panels 9A, 11A, and 10A, Table 3, is shown after five months' exposure. The panels were painted with metallic bituminous paints which have been extensively advertised as the paints most especially adapted for use in the Tropics. It is interesting to note the poorer protective properties of the gray paint applied to panel 9A and the green paint applied to panel 11A, as compared with the brown paint applied to panel 10A, Plate 5, fig. 2. The vehicles of the gray and of the green paints consist essentially of resinous oils, and the pigments contain, among other things, titanic oxide. The brown paint consists of bitumen and petroleum spirit and the pigment is free from titanic oxide. It seems probable that either the resinous oils or the titanic oxide pigments are the immediate cause of the relatively unsatisfactory behavior of the gray and the green paints.

[21] The Manufacture of Paint, 2d ed., London, Scott Greenwood & Son (1915) 134.

PAINTS FOR WOODEN SURFACES

Of the prepared paints received at the laboratory for use on wooden surfaces, the brown paint applied on panel 1, Table 1, and the white paint applied on panel 13B, Table 4, gave the best results. Panel 1, unlike all the rest, received three coats of paint, in compliance with the instructions printed on the label of the original container. It follows that, under the same conditions, the three coats of paint on this panel would show better wearing qualities than the two coats of paint on the other panels. For the first coat, 230 grams of linseed oil and 70 grams of turpentine were added to every kilogram of the paint; for the second coat, 140 grams of linseed oil and 70 grams of turpentine were added to every kilogram of the paint; and for the third coat, the paint was applied as received. The paint vehicle consists almost entirely of linseed oil and the pigment is composed of two-thirds the mixture of basic lead sulphate and zinc oxide, in the proportion of 2 : 1, and one-third ocher.

The paint applied on panel 13B, Table 4, showed excellent protective properties and it was free from discoloration after forty months of exposure (Plate 6). The proportion of oil to volatile thinner in the vehicle is about 3 : 1, and the pigment is composed, approximately, of two-thirds lead sulphate and zinc oxide, in the proportion of 1 : 3, and one-third silicates. It is far superior to the paints applied on panels 14B and 16B (Plate 6). The pigment of the paint on panel 14B, Table 4, consists of a mixture of three-fifths lead carbonate and zinc oxide, in the proportion of 1: 1, and two-fifths baryte; the pigment of the paint on 16B is pure zinc oxide. The condition of the paints at the end of the thirty-second month is shown in Plate 6.

At a glance, both paints, on panels 14B and 16B, are in fairly good condition, although closer examination would show that the paint on panel 14B is beginning to fail. At the end of the thirty-fifth month, 14B failed and 16B was beginning to fail (Plate 7).

Panel 15B, Table 4, Plates 6 and 7, painted with a mixture of lead carbonate and baryte in the proportion of 1: 1, failed at the end of the tenth month. On the other hand, panel 28, Table 4, painted with the pigment consisting of two-fifths zinc oxide and lead carbonate and about three-fifths baryte and silicate gave fair service.

The foregoing results seem to corroborate a general statement enunciated by Chessman [22] several years ago, namely:

A combination paint made from two or more selected pigments is superior in durability to a single pigment paint.

It appears also true:

(1) That paints made up of composite pigments containing zinc oxide show better protective qualities than do paints from which zinc oxide is absent.

(2) That the mixture of zinc oxide and lead sulphate gives better results than does the mixture of zinc oxide and lead carbonate.

(3) That incorporation with the composite zinc oxide and lead sulphate pigment of a reasonable amount of inert material, such as clay, asbestine, ocher, etc., improves the service value of the paint.

Some of these conclusions have been partially established in the paint tests conducted at the experimental farm of the United States Department of Agriculture, Arlington, Va., by the American Society for Testing Materials.[23]

Two ready-mixed green paints of the cheapest variety, applied on panels 24 and 25, Table 2, gave satisfactory results. The vehicles and pigments of these paints are well proportioned. The paint applied on panel 24 contains a relatively smaller quantity of thinner, just sufficient to give it a good penetrating power. This paint is superior to that painted on panel 25, which contains larger proportions of thinner and drier.

SUMMARY AND CONCLUSIONS

The greater proportion of the prepared paints imported into the Philippine Islands are of poor quality. This is especially true of paints for iron surfaces.

The cause of failure of metallic paints is apparently the use of relatively excessive proportions of volatile thinner, resinous drier, and pigments of poor protective qualities, such as whiting and natural barytes.

[22] The Review of Technical Paints, 8th ed., New York City National Paint Works (1911) 10.

[23] Gardner, H. A., Paint Researches and their Practical Application, Washington, D. C., Press of Judd and Detweiler Inc. (1917) 137–149.

Paints containing water as emulsifier are not properly adapted for use in direct contact with iron surfaces. These paints can be used, provided a priming coat of good red-lead paint is first applied.

Bituminous paints consisting of pure asphaltic material and pure mineral volatile solvent possess better protective qualities than do similar paints containing a high percentage of resinous oil.

Lumbang oil is just as good as linseed oil for use in the preparation of paints for iron surfaces.

White paste paints, composed of mixtures of white lead, either carbonate or sulphate, zinc oxide, and a reasonable amount of inert pigment such as baryte or silicates, possess good protective qualities. Lead carbonate alone and baryte, without zinc oxide, is not so good and satisfactory.

A white paint composed of two-thirds the mixture of zinc oxide and lead sulphate, in the proportion of 3 : 1, and one-third silicate, either asbestine or China clay, properly incorporated with the right proportion of oil, appears to possess excellent wearing qualities.

In general, the use of an excessive quantity of volatile thinner, resinous drier, water as emulsifier, or inert pigments is detrimental to the life of the paint.

ILLUSTRATIONS

PLATE 1

FIG. 1. Test fence running north and south.
2. Test fences running east and west.

PLATE 2

FIG. 1. Iron panel, given a priming coat of red-lead paint and a second coat of cheap green paint. Panel 26A.
2. Lumbang-oil paint, painted on iron panel. Condition of paint after sixteen months' exposure. Panel 8A.

PLATE 3

FIG. 1. Two iron panels; 5A, coated with paint containing a high percentage of volatile thinner; 6A, coated with paint containing no volatile thinner.
2. Three iron panels; 18A, coated with paint containing excessive quantities of inert pigments; 19A and 20A, coated with paints high in volatile thinners.

PLATE 4

FIG. 1. Iron panel coated with paint containing excessive quantities of resinous drier. Panel 2B.
2. Iron panel coated with paint high in volatile thinner and inert pigments. Panel 4B.

PLATE 5

FIG. 1. Iron panel coated with bituminous paint, in which mainly resinous oil is used as solvent and the pigment contains titanic oxide. Panel 9A.
2. Iron panel 11A, with treatment similar to that given panel 9A.
3. Iron panel 10A, coated with bituminous paint in which petroleum spirit is used as solvent and the pigment is free from titanic oxide.

PLATE 6

White paints applied to wooden panels. Condition of the paints at the end of the thirty-second month. Results are shown in Table 4.

PLATE 7

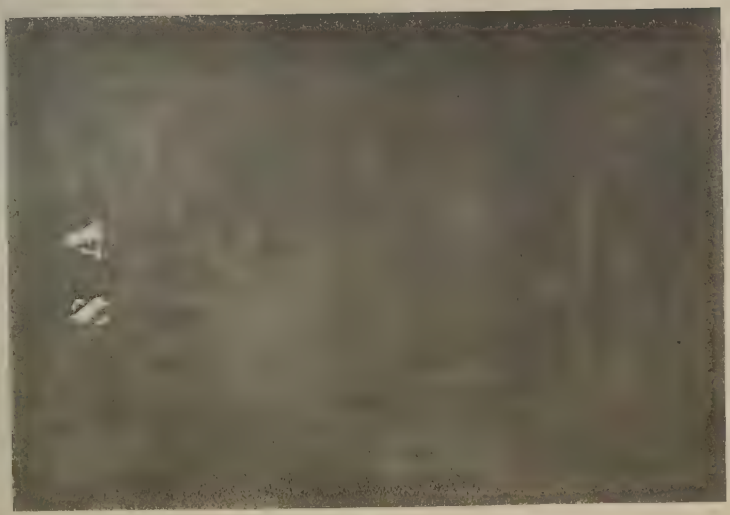
Condition of the paints shown in Plate 6, at the end of the thirty-fifth month.

1

2

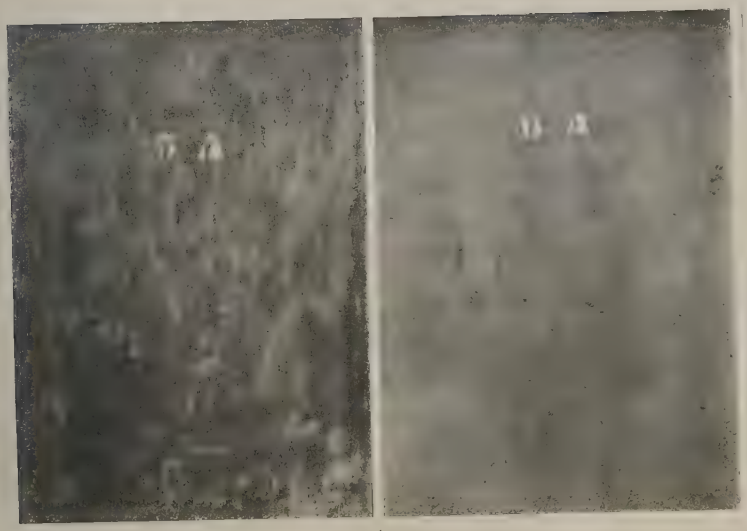
PLATE 1.

1



2

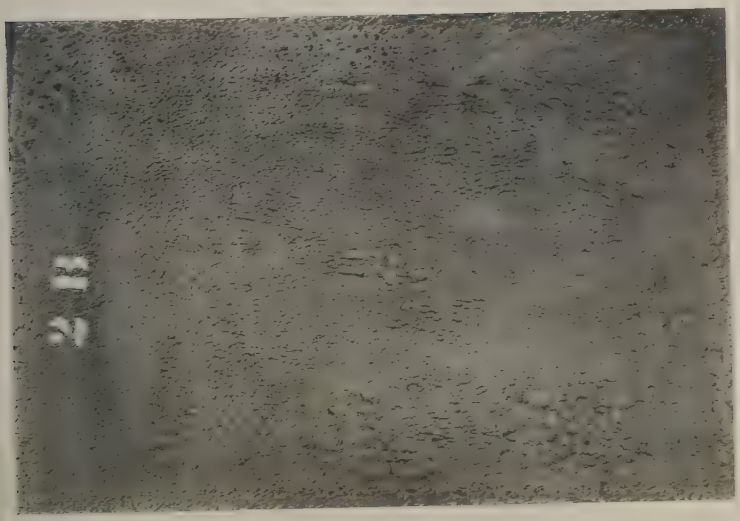
PLATE 2.



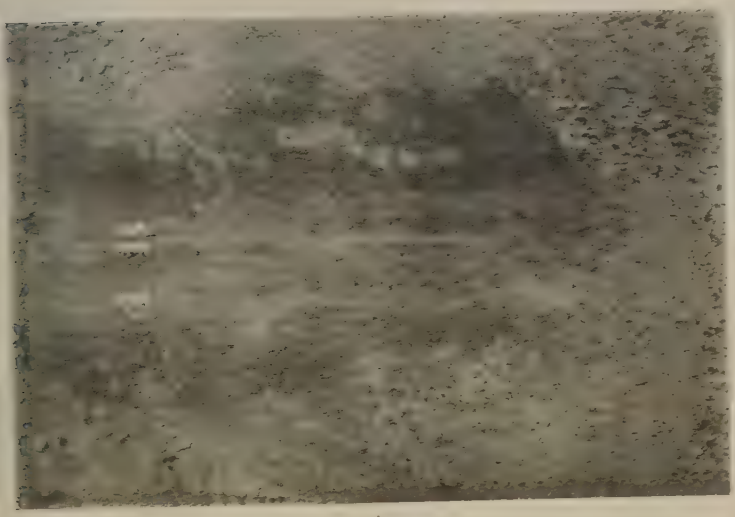
1

2

PLATE 3.

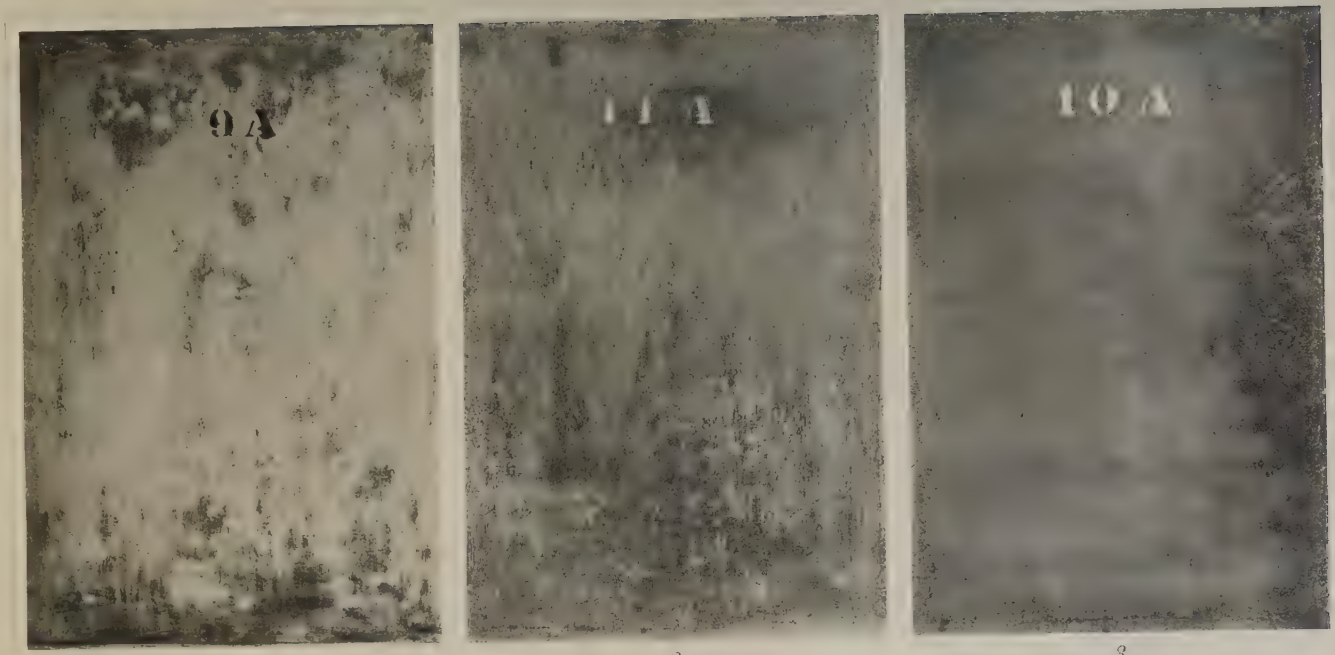


1



2

PLATE 4.



1 2 3

PLATE 5.

PLATE 6.

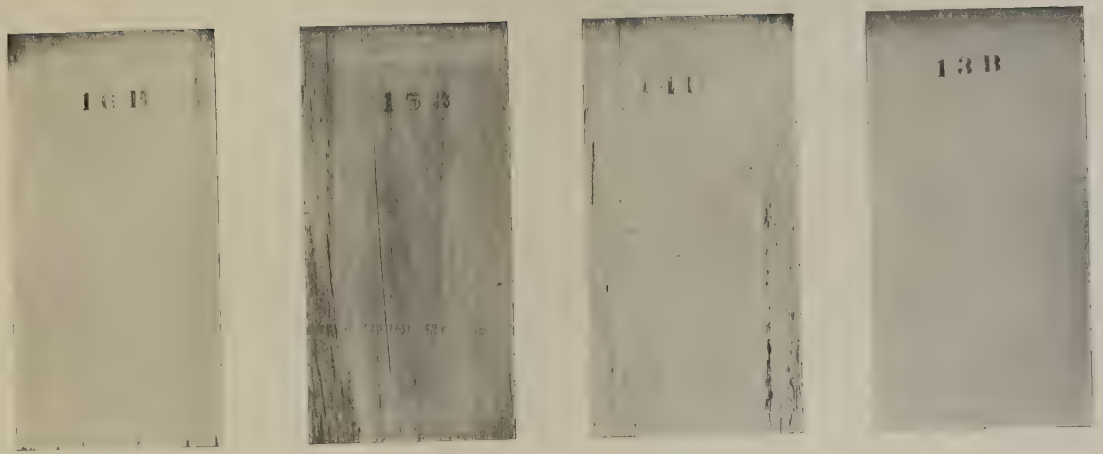


PLATE 7.

THE PHILIPPINE SPECIES OF KUHLIIDÆ

By Albert W. Herre and Heraclio R. Montalban

Of the Bureau of Science, Manila

ONE PLATE

KUHLIIDÆ

The oblong, laterally compressed body is covered with large ciliated scales, the head partly naked; the large protractile mouth has the maxillary exposed and without a supplemental bone, the lower jaw projecting; the jaw teeth in villiform bands; there are also teeth on vomer, palatines, entopterygoids, and ectopterygoids, none on tongue; the preorbital and preopercle denticulate, the opercle with two spines; the lateral line complete, nearly straight.

Dorsal X, 9 to 13, the spinous portion longer than the rayed portion; anal equal to soft dorsal, III, 10 to 12; both dorsal and anal folding into a well-developed sheath; 6 branchiostegals; pseudobranchiæ large; gill rakers long, slender, 9 or 10 + 18 to 25; vertebræ 25 (10 or 11 + 14 or 15).

A small group of marine and fresh-water fishes, abundant in the tropical Pacific, occurring from East Africa to Japan, north Australia, and the islands off the coast of Mexico; certain species apparently occur only in fresh-water rivers, others only about coral reefs.

The Kuhliidæ are closely related to the North American family of sunfishes and black bass, the Centrarchidæ, with which they have skeletal characters in common. In their appearance as well as in their habits the fresh-water Kuhliidæ resemble black bass.

Careful study of the various species of Kuhliidæ confirms us in the belief that they all belong to the same genus. We are therefore unable to follow those authors who divide the family into two genera.

The length does not include the caudal fin.

Genus KUHLIA Gill

Kuhlia Gill, Proc. Acad. Nat. Sci. Phila. 13 (1861) 48; Boulenger, Cat. Perciform Fishes, Brit. Mus. 2d ed. 1 (1895) 35; Regan, Proc. Zool. Soc. London, pt. 3 (1913) 374.

Moronopsis GILL, Proc. Acad. Nat. Sci. Phila. 15 (1863) 82.
Paradules BLEEKER, Ned. Tijd. Dierk. 1 (1863) 257.
Boulengerina FOWLER, Journ. Acad. Nat. Sci. Phila. (1906) 512 (name preoccupied).
Safole JORDAN, Proc. U. S. Nat. Mus. 42 (1912) 655.

The oblong body and head strongly compressed laterally; the mouth oblique, short; the maxillary 2 to 2.7 times in head.

Coloration silvery, in some species more or less spotted or mottled with olive brown or black.

We are unable to recognize generic differences based on the comparative length of the maxillary or the relative length and height of the dorsal and anal; a series of specimens shows no essential differences in these characters.

Species living in fresh water are active fishes with much the same habits as the North American black bass and sunfishes. They take the hook readily, offer fair sport to the angler, and are good pan fish.

Key to the Philippine species of Kuhlia.

a^1. Caudal fin with two pairs of converging diagonal black bands and a median longitudinal one; 50 to 55 scales in lateral line.... **K. taeniura.**
a^2. Caudal fin without two pairs of oblique black bands.
b^1. Fifty-three to 56 scales in lateral line; caudal edged with blackish all round.
Twenty-four to 28 gill rakers on lower part of first arch..... **K. malo.**
b^2. Forty to 44 scales in lateral line; 17 or 18 gill rakers on lower part of first arch.
c^1. Body with irregular blackish spots above lateral line; no blackish spots at base of anal..... **K. marginata.**
c^2. Body with black spots all over sides at scale bases; anal usually with rounded spots at base..... **K. rupestris.**

KUHLIA TAENIURA (Cuvier and Valenciennes). Plate 1, fig. 1.

Dules taeniurus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 85; GÜNTHER, Cat. Fishes 1 (1859) 267; KNER, Reise Novara, Fische (1865) 47.
Kuhlia taeniura JORDAN and BOLLMAN, Proc. U. S. Nat. Mus. 12 (1889) 159; BOULENGER, Cat. Fishes, ed. 2, 1 (1895) 39; HERRE, Occ. Papers Bishop Museum 2 (1903) 129; JORDAN and SEALE, Bull. Bur. Fisheries 25 (1905) 255; JORDAN and THOMPSON, Proc. U. S. Nat. Mus. 41 (1912) 522.
Perca argentea BENNETT, Fishes Ceylon (1834) 22, pl. 22.
Dules bennetti PETERS, Monatsb. Akad. Wiss. Berlin (1855) 532; GÜNTHER, Cat. Fishes 1 (1859) 270.
Dules argenteus KLUNZINGER, Verh. Zool.-Bot. Ges. Wien 20 (1870) 62; GÜNTHER, Fische der Südsee 1 (1873) 25, pl. 19, fig. C; DAY, Fishes of India (1878) 67, pl. 18, fig. 2.
Moronopsis taeniurus BLEEKER, Atlas Ichth. 7 (1876) 119, pl. 345, fig. 5.

Moronopsis argenteus KLUNZINGER, Fische des Rothen Meeres (1884) 25.

Kuhlia arge JORDAN and BOLLMAN, Proc. U. S. Nat. Mus. 12 (1889) 159.

Dorsal X, 10 or 11; anal III, 11; there are 54 scales on the lateral line to the base of the caudal fin, 6 between the lateral line and the origin of the dorsal, and 11 between the lateral line and the origin of the anal.

The depth of the oblong, strongly compressed body contained from 3 to 3.2 times in length; the head, which is much longer than deep, from 3.6 to 3.8 times in length of body; the elongate and compressed caudal peduncle lowest posteriorly, its least depth 2.3 times in length of head or from 8.2 to 8.6 times in the total length; the interorbital space moderately convex and narrowest in front, its least width 3.4 times in head and a little narrower than eye diameter, which is contained 3.2 times in head; the snout from 1.4 to 1.5 times in maxillary, which is contained 2.5 to 2.7 times in head and ends posteriorly below anterior third of eye; the narrowest portion of the serrated preorbital about a third of orbit's diameter; the gape of the moderately small mouth markedly oblique and the lower jaw slightly projecting; the preopercle serrated below and behind; on posterior edge of opercle are two flat, rather sharp spines.

The top of the head naked as are the orbital ring, snout, and the edges of preopercle; the cheek has four longitudinal rows of scales; the lateral line slightly arched anteriorly; the fifth dorsal spine is highest and contained from 1.5 to 1.6 times in head, or nearly as long as pectoral, which is 1.4 times; the last dorsal spine contained from 2.2 to 2.3 times in head, a little higher than third anal and as long as ventral spine; the dorsal and anal rays decrease in height posteriorly, their first rays lower than the highest dorsal spines; the caudal fin deeply forked, with the lobes equally produced, both pectoral and ventral fins are pointed and do not quite extend to above anus.

In alcohol the ground color is yellowish silvery which passes into bluish gray on back; there appears to be a series of silvery white longitudinal lines passing through center of each row of scales; the rayed dorsal broadly margined with blackish; the caudal fin has five black bands, the middle one along the middle rays and two pairs which converge posteriorly; the spinous dorsal and other fins yellowish.

This species, which undoubtedly occurs in the Philippines, is described here from two examples, 86 and 120 millimeters

long, obtained in Guam, and from twenty-seven others, the largest only 39 millimeters long, collected at Tanegashima Island, Japan. It is easily distinguished by the presence of the five blackish bands on the caudal fin, and is widely distributed. It occurs from the east coast of Africa, through the seas of India and the East Indian Archipelago and the islands of the tropical Pacific to the islands off the west coast of Mexico and northward to southern Japan. Unlike most other members of the family, this species is strictly marine.

Kuhlia malo (Cuvier and Valenciennes).

Dules malo CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 360; GÜNTHER, Cat. Fishes 1 (1859) 270.

Kuhlia malo BOULENGER, Cat. Fishes Brit. Mus. 2d ed. 1 (1895) 40; JORDAN and EVERMANN, Bull. U. S. Fish Comm. 23[1] (1905) 207; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 242.

Dules mato LESSON, Voy. Coquille, Zool. 2 (1831) 223.

Dules marginatus GÜNTHER, Fische der Südsee 1 (1873) 24, pro parte.

Moronopsis sandvicensis STEINDACHNER, Sitzb. Ak. Wiss. Wien 96 (1887) 56, pl. 1, fig. 1.

Dorsal X, 11; anal III, 11; 53 to 56 scales in lateral line, 5 or 6 above and 14 or 15 below lateral line; gill rakers 25 to 28 on lower part of anterior arch.

Depth 2.6 to 3 times, head 3.33 to 3.66 times in length; snout short, rather blunt, half to two-thirds diameter of the very large eye, which is 2.5 to 3.2 times in head; width of convex interorbital 3 to 3.3 times in head; maxillary extending to below anterior margin of eye or a little beyond, 3 times in head; mouth oblique, lower jaw projecting, mandible 2.3 times in head; angle and lower border of preopercle finely denticulated; lower opercular spine strong.

Fifth dorsal spine longest, 1.5 to 1.66 times in head, a little longer than anterior soft rays; tenth dorsal spine longer than ninth, equal to or a little shorter than third; base of soft dorsal shorter than anal base; anal longer than its distance from caudal; third anal spine a little longer than second, nearly equal to tenth dorsal spine; pectoral 1.5 times in head; ventrals usually a little shorter, reaching anus or only three-fourths of the distance; caudal deeply forked; four rows of scales on cheeks, those on bases of vertical fins very small; about 12 scales before dorsal.

Color silvery, darker above; first dorsal and caudal narrowly edged with black.

This handsome little fish reaches a length of about 250 millimeters. It occurs from the coast of South Africa to Tahiti, where it was first collected, and northward to the Hawaiian Islands. It abounds in running fresh-water streams throughout Polynesia and takes the hook readily.

We have seen no Philippine specimens. Seale and Bean had a small specimen from Zamboanga. It should be expected to occur in Mindanao, since it is found in the Moluccas.

KUHLIA MARGINATA (Cuvier and Valenciennes). Plate 1, fig. 3.

Dules marginatus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 87, pl. 52, and 7 (1831) 356; HOMBRON and JACQUINOT in Voy. Pôle Sud, Poiss. (1853) 41, pl. 3, fig. 3; GÜNTHER, Cat. Fishes 1 (1859) 268.

Dules marginatus (in part) GÜNTHER, Fische der Sudsee 1 (1873) 24.

Kuhlia marginata BOULENGER, Cat. Fishes ed. 2, 1 (1895) 38; JORDAN and SEALE, Fishes of Samoa, Bull. Bur. Fisheries 25 (1905) 255; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) (1908) 254; JORDAN and THOMPSON, Proc. U. S. Nat. Mus. 41 (1912) 525; WEBER, Siboga Exp., Fische (1913) 194.

Dules maculatus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 357.

Dules malo (not of Cuvier and Valenciennes) HOMBRON and JACQUINOT in Voy. Pôle Sud, Poiss. (1846) 41, pl. 3, fig. 4.

Paradules marginatus BLEEKER, Ned. Tijd. Dierk. 1 (1863) 257.

Moronopsis ciliatus BLEEKER, Atlas Ichth. 7 (1876) 120, pl. 316, fig. 1, and 8 (1877) pl. 324, fig. 2.

Dules ciliatus MACLEAY, Proc. Linn. Soc. N. S. Wales 7 (1882) 237.

Dules papuensis MACLEAY, Proc. Linn. Soc. N. S. Wales 8 (1883) 257.

Dorsal X, 10 or 11; anal III, 11; there are 40 to 44 scales on the lateral line, 5 between the lateral line and the origin of dorsal, and 8 between the lateral line and the origin of anal; 16 to 18 gill rakers on lower part of first arch.

The oblong and compressed body 2.8 to 3 times in length, depth of the upper and lower outlines equally and almost evenly arched; the head much longer than deep, 3.2 to 3.5 times in length of body, its upper profile nearly straight; the compressed, rather long caudal peduncle lowest posteriorly, the least depth 2.2 to 2.7 times in length of head or 7.6 to 8.3 times in that of body; the wide interorbital space moderately convex, its narrowest portion 2.9 to 3.4 times in head; the diameter of the large, rounded eye from 3 to 3.4 times in length of head and slightly longer than snout, which is contained from

3.3 to 3.8 times; the long maxillary is 2.1 to 2.5 times in head and extends posteriorly to below anterior third of eye; the least width of preorbital is hardly one-third the diameter of eye; the large mouth oblique, with the lower jaw slightly projecting; two nostrils, close together, in front of each eye, the anterior one with a fleshy rim and the other a vertical slit; the preorbital coarsely serrated; the preopercle finely serrated on its lower and hind edges; the opercle armed posteriorly with two flat, rather sharp spines, the lower one much the stronger.

There are no scales on top of head, and none present on snout, orbital ring, chin or both limbs of preopercle; the cheek has four longitudinal rows of scales; the lateral line is highest anteriorly and curves downward below third and fourth dorsal spines; the fifth dorsal spine the highest and slightly higher than the last, which is about twice in head; the third anal spine, which is contained from 2.1 to 2.6 times in head, is about as long as ventral spine; the dorsal and anal rays decrease in height posteriorly, the anterior rays about as high as the highest dorsal spines; the caudal fin rather deeply forked, with pointed lobes; the pectoral fin is contained from 1.4 to 1.8 times in length of head and terminates above the fifth or sixth scale in front of anus; the ventral fin extends almost to anus.

The ground color in alcohol silvery grayish and frequently with irregular blackish spots above lateral line; soft dorsal and anal narrowly edged with white and having a blackish submarginal band which is broader in front; the caudal fin is narrowly edged with white above and below, and has a blackish posterior border which is rather broad in the young; this blackish border appears to be margined in front with whitish; there is a blackish spot at axil of pectoral.

We have examined fifty-seven alcoholic specimens, varying in length from 27 to 165 millimeters, collected at the following localities; Bataan Province; Pansipit River; Batangas; Pinamalayan, Mindoro; Bigaa and Arimbay Rivers, Albay Province; San Jose de Buenavista, Antique; Dumaguete, Oriental Negros; Lazi, Siquijor Island; Cagayan de Misamis; Kolambugan and Malabang Spring, Lanao; Balabac Island; Davao, Davao; Saub River and southern coast, Cotabato Province; Gandasole River, Jolo Island; and Malum River, Tawitawi Island. This fish has been previously recorded from the Philippines by Jordan and Richardson from Aparri, Cagayan Province, and Baco River, Mindoro, and by Jordan and Thompson from Mindoro.

This species occurs throughout the East Indies and southeastward in the South Pacific from the Gilbert Islands to the Society Islands.

KUHLIA RUPESTRIS (Lacépède). Plate 1, fig. 2.

Centropomus rupestris LACÉPÈDE, Hist. Nat. Poiss. 4 (1802) 252 and 273.

Kuhlia rupestris BOULENGER, Cat. Fishes ed. 2, 1 (1895) 36; JORDAN and SEALE, Fishes of Samoa, Bull. Bur. Fisheries 25 (1905) 255; SEALE and BEAN, Proc. U. S. Nat. Mus. 33 (1907) 242; JORDAN and RICHARDSON, Bull. Bur. Fisheries 27 (1907) (1908) 254.

Dules rupestris CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 89, and 7 (1831) 359; GÜNTHER, Cat. Fishes 1 (1859) 268; PETERS, Monatsber, Akad. Wiss. Berlin (1868) 256; SAUVAGE, Hist. Madag., Poissons (1875–1899) 150, pl. 41B, fig. 3.

Perca ciliata CUVIER and VALENCIENNES, Hist. Nat. Poiss. 2 (1828) 38.

Dules fuscus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 88; GÜNTHER, Cat. Fishes 1 (1859) 268; SAUVAGE, Hist. Madag., Poissons (1875–1899) 149, pl. 15, fig. 4.

Dules guamensis CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 359; HOMBRON and JACQUINOT in Voy. Pôle Sud, Poiss. (1853) 41, pl. 3, fig. 1; GÜNTHER, Cat. Fishes 1 (1859) 269.

Dules vanicolensis CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 359; HOMBRON and JACQUINOT in Voy. Pôle Sud, Poiss. (1853) 42, pl. 3, fig. 2.

Percichthys ciliata GÜNTHER, Cat. Fishes 1 (1859) 62.

Kuhlia ciliata GILL, Proc. Acad. Nat. Sci. Phila. (1861) 48.

Paradules rupestris BLEEKER, Ned. Tijd. Dierk. 2 (1865) 276.

Moronopsis rupestris BLEEKER, Atlas Ichth. 7 (1876) 121, and 8, pl. 339, fig. 2.

Dules marginatus DAY, Fishes of India (1878) 67, pl. 18, fig. 1.

Dules haswelli MACLEAY, Proc. Linn. Soc. N. S. Wales 5 (1880) 359.

Moronopsis fuscus STEINDACHNER, Sitzb. Akad. Wien 82 (1881) 240.

Dorsal X, 11; anal III, 10; there are 41 to 43 scales on the lateral line to the base of the caudal, 5 between the lateral line and the origin of dorsal, and 9 between the lateral line and the origin of anal; 17 or 18 gill rakers on lower part of first arch.

The oblong body a little compressed, with the profiles evenly and equally arched; the depth contained from 2.6 to 2.9 times in length; the length of head equal to or a little less than depth of body, and from 2.6 to 3.1 times in total length; the depth of the rather elongate, compressed caudal peduncle from 7.1 to 7.8 times in length of body, the slightly arched interorbital contained from 3 to 3.5 times in length of head, and slightly wider than length of snout, which is contained from 3.2 to 3.6 times; the rounded eye moderately large, its diameter 3.3 to

4.6 times in head; the long maxillary, which ends posteriorly below center or posterior third of pupil, is from 2 to 2.3 times in length of head or nearly twice eye; the least width of preorbital equal to or less than a third diameter of eye; the mouth rather large, with the lower jaw slightly in advance of the upper; two rounded nostrils close together in front of each eye, the first one provided with a fleshy rim which is highest posteriorly and the other a simple opening; the preorbital finely serrated, as are the inferior and posterior edges of preopercle; the opercle has two flat, rather sharp spines behind, the lower one much the stronger.

The top of head rugose and naked; the snout, orbital ring, edges of preopercle, and chin also unscaled; four longitudinal rows of scales on cheek; the lateral line is highest anteriorly and curves posteriorly below fourth and fifth dorsal spines; the fifth dorsal spine the highest, 1.9 to 2.4 times in head; the third anal spine, which is contained from 2.3 to 3.2 times in length of head, is higher than last dorsal on ventral spine; the dorsal and anal rays decrease in height posteriorly, the anterior rays much higher than the highest dorsal spine; the caudal fin emarginate, with the lobes rounded or obtusely pointed; the pectoral fin is 1.7 to 2 times in head, and falls much short of reaching a vertical through anus; the ventral fin extends almost to anterior border of anus.

In alcohol the ground color is yellowish brown, much darker above and paler on belly, with a silvery gloss over all but most evident on sides; some or all of the scales have a black spot at base or at posterior free margin; rounded black spots usually present at base of anal fin; a portion of the soft dorsal blackish, the caudal fin has a wide, rather indistinct black band and a whitish edge on each lobe; pectoral and ventral yellowish, the former with a blackish brown spot at axil.

Of this widely distributed species, we have examined in the Bureau of Science collection forty-eight specimens, 30 to 253 millimeters long, collected at the following localities. Abulug, Cagayan; Kiangan, Ifugao; Bataan Province; Pansipit River, Batangas; Nauhan River, Mindoro; Pawis River, Legaspi, Albay; Ulot River, Samar; Concepcion, Busuanga Island; Cuyo Island; Anajawan and Cabalian, Leyte; Dumaguete, Oriental Negros; Titunod River, Kolambugan, Lanao; Balabac Island; Gandasole, Bangtoli, and Tagbili Rivers, and Asturias, Jolo Island; and

Tawitawi Island. The collection contains also two specimens from Fiji which are identical with the Philippine examples.

Jagor was the first to collect this fish in the Philippines, obtaining it from Basey River, Samar, and Burauen River, Leyte. Mearns collected it at Zamboanga as recorded by Seale and Bean, and McGregor caught the specimens recorded by Jordan and Richardson from Mindoro.

This widespread species is common in rivers throughout the Indian and tropical Pacific oceans; it occurs on the east coast of Africa, in the East Indies, and in Polynesia to Guam and the Tonga Islands.

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ILLUSTRATIONS

[Drawings by P. Bravo.]

PLATE 1

FIG. 1. *Kuhlia taeniura* (Cuvier and Valenciennes).
2. *Kuhlia rupestris* (Lacépède).
3. *Kuhlia marginata* (Cuvier and Valenciennes).

PLATE 1.

NEW STEPHANIDÆ FROM BORNEO AND THE PHILIPPINE ISLANDS, II

By E. A. Elliott

Fellow of the Zoological Society of London and of the Entomological Society of London

Four of the six subfamilies of the Stephanidæ are represented in this collection; only the South American *Hemistephanus* and the African *Neostephanus* are wanting, and they are not likely to occur in this region. The number of species appears rather large, but this is probably due to the number of islands, each of which may have given rise to special variations, from differences of climate, position, vegetation, or isolation. Nothing definite appears to have been ascertained as to the hosts.

As a general rule, the males appear to agree with the females in the sculpture of the head, thorax, and median segment; the petiole is usually longer in proportion, and often differs in sculpture; the color is no trustworthy guide. It is impossible to assign many males to their true females, and they are described as separate species.

It should be noted that the term "normal" is used for the following forms: Antennæ, second flagellar joint twice as long as first, third as long as first and second together; prothorax, neck transstriate, usually more coarsely apically, and as long as or little longer than the smooth semiannular; scutellum, central lobe smooth and shining, with small or medium marginal punctures, lateral lobes evenly, not very coarsely punctate.

In the genus *Stephanus* the species are mostly large, from 15 to over 30 millimeters in length of body, with terebra up to 40 millimeters. The males are, on an average, about 5 to 8 millimeters smaller.

Genus STEPHANUS Jurine

Key to species of the genus Stephanus.

FEMALES

10. 1. Terebra black.
5. 2. Terebra as long as body.
4. 3. Frons granulate, neck smooth, head red; 16 mm.

S. nigricauda (Sichel).

3. 4. Frons irregularly rugose, head black, frons red, cheeks yellow; 14 mm..... **S. unicolor Schlett.**
2. 5. Terebra longer than body.
7. 6. Neck normal, oblique rugose, semiannular closely punctate, frons oblique rugose; 22 to 30 mm..... **S. sulcifrons Schlett.**
6. 7. Neck short.
9. 8. Neck quadrate, semiannular apically punctate, frons arcuate striate; 18 to 22 mm..... **S. quadraticollis sp. nov.**
8. 9. Neck shorter than the smooth semiannular, frons granulate, occiput basally smooth; 14 to 18 mm..... **S. elegans sp. nov.**
1. 10. Terebra banded.
14. 11. Terebra shorter than body, petiole very short.
13. 12. Frons transstriate, vertex and occiput reticulate or transrugose punctate, semiannular centrally transstriate; 22 mm. **S. brevicoxis Elliott.**
12. 13. Frons arcuate striate, vertex and occiput rugose, semiannular diffusely punctate; 14 to 18 mm..... **S. curtus Elliott.**
11. 14. Terebra as long as or longer than body.
24. 15. Terebra as long as body.
17. 16. Head black, vertex and occiput laterally punctate; 20 mm. **S. atriceps (Kieffer).**
16. 17. Head red.
23. 18. Frons transrugose.
20. 19. Posterior margin of head simple; 23 mm..... **S. tarsatus (Sichel).**
19. 20. Posterior margin of head bordered.
22. 21. Occiput basally and laterally smooth, petiole shorter than rest of abdomen, wings hyaline; 19 mm..... **S. inaequalis sp. nov.**
21. 22. Occiput transstriate throughout, petiole slender, longer than the rest of abdomen, wings infumate, centrally darker; 23 mm. **S. philippinensis Ceballos.**
18. 23. Frons granulate, vertex and occiput striate, laterally punctate; 20 mm ..... **S. punctatus sp. nov.**
15. 24. Terebra longer than body.
36. 25. Petiole as long as rest of abdomen.
29. 26. Semiannular transstriate, frons and vertex arcuate striate.
28. 27. Legs black; 31 to 37 mm..... **S. tinctipes Kieffer.**
27. 28. Legs red, hind femora nigrescent; 25 mm. **S. tinctipes var. rubripes Kieffer.**
26. 29. Semiannular smooth.
31. 30. No stronger carina between posterior ocelli, vertex laterally, occiput basally punctate, anterior legs black; 17 mm. **S. nigripes sp. nov.**
30. 31. With stronger carina between posterior ocelli.
33. 32. Vertex and occiput reticulate punctate, compressed part of hind tibiæ black; 14 to 32 mm..... **S. aequalis sp. nov.**
32. 33. Vertex and occiput otherwise sculptured.
35. 34. Frons strongly arcuate striate, apically carinate, occiput arcuate striate, scutellum longitudinally sulcate; 26 mm. **S. impressus Elliott.**
34. 35. Frons subarcuate striate, occiput basally transstriate, vertex and occiput longitudinally impressed; 17 mm.. **S. sulcatus Elliott.**

25. 36. Petiole shorter than rest of abdomen.
38. 37. Semiannular transstriate, frons transversely, vertex and occiput arcuate rugose, latter basally more transversely; 20 to 36 mm. **S. ducalis Westwood.**
37. 38. Semiannular not entirely transstriate.
44. 39. Semiannular apically transstriate, basally smooth.
41. 40. Hind coxæ smooth and shining between transcarinæ, vertex centrally transstriate, laterally reticulate punctate; 21 to 25 mm. **S. glabricoxis sp. nov.**
40. 41. Hind coxæ more or less regularly transstriate or transcarinate.
44. 42. Hind coxæ transstriate, vertex and occiput centrally transstriate, laterally reticulate punctate; 22 to 25 mm. **S. collectivus sp. nov.**
42. 43. Hind coxæ transcarinate, vertex and occiput arcuate striate, latter basally more transversely; 27 to 35 mm **S. similis sp. nov.**
39. 44. Semiannular entirely smooth.
46. 45. Petiole very short and stout, head arcuate striate; 20 mm. **S. petiolatus sp. nov.**
45. 46. Petiole little shorter than rest of abdomen, not very stout.
48. 47. Occiput longitudinally carinate, vertex and occiput irregularly rugose; 25 mm..... **S. panayanus sp. nov.**
47. 48. Occiput longitudinallly impressed.
50. 49. Body dark red or rufescent, head finely and evenly subarcuate striate; 17 to 20 mm..... **S. ruber sp. nov.**
49. 50. Body black, head mostly red.
54. 51. Occiput more or less reticulate punctate.
53. 52. Occiput reticulate punctate, centrally basally transstriate, mesonotum diffusely punctate with central row of round punctures, metapleuræ reticulate punctate; 19 to 28 mm. **S. reticulatus Elliott.**
52. 53. Occiput centrally arcuate carinate, laterally reticulate punctate, mesonotum centrally smooth with row of oblong punctures; 23 to 31 mm..... **S. variantius Elliott.**
51. 54. Occiput not reticulate punctate.
56. 55. Mesonotum densely and coarsely punctate, median segment cribrate punctate; 20 to 40 mm..... **S. coronator (Fabricius).**
55. 56. Mesonotum centrally smooth, laterally rugose, median segment evenly and not deeply punctate; 19 to 22 mm **S. samaris sp. nov.**

MALES

6. 1. Head black.
3. 2. Occiput laterally punctate; 18 mm..... **S. atriceps (Kieffer).**
2. 3. Occiput not punctate.
5. 4. Frons, vertex, and occiput coarsely arcuate punctate, legs rufescent; 14 mm..... **S. rugicaput sp. nov.**
4. 5. Frons, vertex, and occiput irregularly rugose, legs bright rufotestaceous, basal half of hind tibiæ dark brown; 17.5 mm. **S. tricolor sp. nov.**
1. 6. Head rufescent or red.
10. 7. Body dark red or rufescent.
9. 8. Body dark red, pronotum sometimes black, neck apically coarsely, basally finely transstriate; 10 to 23 mm..... **S. ruber sp. nov.**

8. 9. Body rufescent, neck apically smooth; 14 mm....**S. rufus sp. nov.**
7. 10. Body chiefly or entirely black.
12. 11. Neck apically transstriate, basally smooth; petiole short; 16 mm. **S. lepidus sp. nov.**
11. 12. Neck not basally smooth.
14. 13. Neck quadrate, occiput basally smooth, hind tarsi red; 14 to 20 mm ..... **S. quadraticollis sp. nov.**
13. 14. Neck normal or elongate, not quadrate.
18. 15. Petiole not more than half as long as rest of abdomen.
17. 16. Head light red, abdomen from second segment rufous; 10.5 mm. **S. linearis sp. nov.**
16. 17. Head red, abdomen black; 17 mm..... **S. curtus Elliott.**
15. 18. Petiole shorter than but more than half as long as rest of abdomen.
20. 19. Petiole unusually stout; frons, vertex, and occiput arcuate striate, median segment reticulate punctate; 20 mm. **S. petiolatus sp. nov.**
19. 20. Petiole normal.
22. 21. Hind tibiæ bicolored, compressed part black; occiput laterally reticulate punctate; 16 to 22 mm..... **S. aequalis sp. nov.**
21. 22. Hind tibiæ unicolorous.
24. 23. Pleuræ, petiole, and legs with long whitish hairs; third flagellar joint little longer than second; 17 mm..... **S. hirsutus sp. nov.**
23. 24. Pubescence normal and not conspicuous.
36. 25. Wings infumate, centrally darker.
27. 26. Occiput mostly reticulate punctate; 21 mm.... **S. reticulatus Elliott.**
26. 27. Occiput transversely or arcuately rugose.
31. 28. Occiput transrugose, median segment coarsely reticulate rugose.
30. 29. Legs black, joints red; 22 to 26 mm..... **S. tinctipes Kieffer.**
29. 30. Anterior tibiæ and all tarsi red-brown; 20 mm. **S. tinctipes var. rubripes Kieffer.**
28. 31. Occiput apically arcuately, basally transversely rugose; median segment cribrate punctate.
33. 32. Legs black, semiannular transstriate; 20 to 23 mm. **S. ducalis Westwood.**
32. 33. Anterior legs chestnut brown or red.
35. 34. Anterior legs chestnut brown, semiannular smooth, metapleuræ coarsely punctate; 15 to 30 mm..... **S. coronator (Fabricius).**
34. 35. Anterior legs red, semiannular apically more or less transstriate, metapleuræ smooth above; 14 to 25 mm.....**S. similis sp. nov.**
25. 36. Wings not centrally darker.
38. 37. Wings evenly infumate, median segment scrobiculate punctate, abdomen fuscopiceous; 24 mm..... **S. tarsatus (Sichel).**
37. 38. Wings basally infumate, apically hyaline, median segment rugose punctate, abdomen black; 16 mm..... **S. variantius Elliott.**

STEPHANUS NIGRICAUDA (Sichel), female.

Megischus nigricauda SICHEL, Soc. Ent. France; Annales IV 5 (1865). *Stephanus nigricauda* SCHLETT., Berl. Ent. Zeit. 33 (1889) 106; ELLIOTT, Mon. of Hymenop. Fam. Stephanidæ, Proc. Zool. Soc. London (1922) 722, female.

STEPHANUS UNICOLOR Schlett., female.

Stephanus unicolor SCHLETT., Berl. Ent. Zeit. 33 (1889) 104; ELLIOTT, Mon. of Hymenop. Fam. Stephanidæ, Proc. Zool. Soc. London (1922) 725, female.

STEPHANUS SULCIFRONS Schlett., female.

Stephanus sulcifrons SCHLETT., Berl. Ent. Zeit. 33 (1889) 110; ELLIOTT, Mon. of Hymenop. Fam. Stephanidæ, Proc. Zool. Soc. London (1922) 724, female.

STEPHANUS QUADRATICOLLIS sp. nov.

Female.—Frons coarsely arcuate striate, vertex transcarinate, centrally impressed, occiput apically irregularly, centrally more regularly transstriate, basally narrowly smooth, posterior margin of head finely bordered; posterior tubercles well developed in the larger specimens, less so in the smaller; scape longer than cheeks, nearly three times as long as the first flagellar joint, antennæ normal; neck very short, quadrate, deeply bifoveate, with central carina, semiannular punctate, basally smooth; mesonotum centrally smooth with three distinct rows of punctures, apically and laterally punctate; central lobe of scutellum smooth, with large marginal puncture, lateral lobes very diffusely punctate; propleuræ very finely transstriate; mesopleuræ finely aciculate above, punctate beneath, metapleuræ smooth above, otherwise punctate, separated by a punctate or crenulate sulcus from the cribrate punctate median segment; petiole basally rugose, then gradually more regularly transstriate to the narrowly smooth apex, much shorter than the remaining segments; terebra longer than body, black. Hind coxæ transcarinate, as long as the smooth bidentate femora, tibiæ compressed to beyond middle. Radius in forewing emitted from about middle of stigma, its basal section more than half as long as the distal.

Black; head and two basal antennal joints red, anterior legs and hind tarsi dark red. Wings lightly infumate, median cell and a streak below it to margin of wing brownish.

Length, 18 to 22 millimeters; abdomen, 12 to 15; petiole, 5 to 6; terebra, 23 to 27.

Male.—The petiole almost smooth and tarsi 5-jointed, otherwise as in female.

Length, 14 to 20 millimeters; abdomen, 10 to 13; petiole, 3 to 5.

BORNEO, Sandakan. NEGROS, Cuernos Mountains. NORTHWESTERN PANAY (*Baker*).

This species resembles *S. nigricauda* Sichel in the quadrate neck and the black terebral sheaths, but differs entirely in sculpture.

Sichel states that the occiput is basally striate, apically smooth, a type of sculpture unknown to me. Has he reversed the positions?

STEPHANUS ELEGANS sp. nov.

Female.—Frons granulate, vertex and occiput transstriate, latter basally broadly smooth, both longitudinally impressed, posterior tubercles obsolete, posterior margin of head bordered; scape as long as cheeks, more than twice as long as the first flagellar joint, antennæ normal; neck rugose, shorter than the semiannular, which is apically finely rugose, basally smooth; mesonotum smooth and shining, diffusely punctate, with central longitudinal impression, the lateral ones only apically distinct; scutellum normal; mesopleuræ very finely transstriate above, punctate beneath, metapleuræ smooth above, otherwise punctate, median segment rather finely and not deeply punctate; petiole finely transstriate, shorter than the remaining smooth, shining segments; terebra longer than body, black. Hind coxæ finely striate between coarser rugosities, femora bidentate, about as long as the coxæ, tibiæ longer than femora, but shorter than femora and trochanters together, compressed to beyond middle, metatarsus not quite twice as long as the remaining joints. Radius emitted from middle of stigma, its proximal section not half as long as the distal.

Black; head and three or four antennal joints red; wings hyaline, centrally slightly infumate, stigma and nervures black-brown.

Length, 14 millimeters; abdomen, 9; petiole, 4; terebra, 16.

SIBUYAN (*Baker*).

STEPHANUS BREVICOXIS Elliott.

Stephanus brevicoxis ELLIOTT, Philip. Journ. Sci. 29 (1926) 517, female.

STEPHANUS CURTUS Elliott.

Stephanus curtus ELLIOTT, Philip. Journ. Sci. 29 (1926) 517, female.

Female and male.—Frons basally arcuate, apically transversely striate, vertex and occiput irregularly reticulate or transrugose punctate, three carinæ behind posterior ocelli, posterior margin of head bordered, posterior tubercles distinct, scape longer than cheeks, second flagellar joint half as long again as first, third as long as or slightly longer than first and second together; neck rather short, apically transcarinate, basally transstriate, cen-

trally impressed (this is indistinct in some examples), semiannular smooth, apically centrally more or less lightly transstriate; mesonotum centrally apically smooth, otherwise closely, sometimes confluently punctate, three rows of punctures distinct; lateral lobes of scutellum punctate; meso- and metapleuræ smooth above, punctate beneath, latter separated by a rugose sulcus and sometimes an indistinct sulcus from the cribrate punctate median segment; petiole in female stout and transstriate, in male slenderer and more finely striate, little more than half as long as the remaining segments; terebra in female shorter than body, with subapical white or yellowish band, three or four times as long as the black apex. Hind coxæ coarsely transstriate, femora bidentate, smooth, about as long as the coxæ, tibiæ as long as femora and trochanters together, compressed to middle, metatarsi about three times as long as the remaining joints in female, about as long in male. Radius emitted from beyond middle of stigma, distal section fully twice as long as the proximal.

Black; head red, with or without a central black line on vertex and occiput, antennæ basally dark red, anterior legs rufescent. Wings slightly infumate, discal and outer submedian cells brownish; two pale brown streaks in hind wing; stigma and nervures red-brown.

Length, female, 14 to 18 millimeters; abdomen, 10 to 11; petiole, 3.5 to 4.5; terebra, 11 to 16; band, 3 to 4; apex, 1 to 1.5. Male, 17 millimeters; abdomen, 10; petiole, 3.5.

BORNEO, Sandakan (*Baker*).

This is an amended and extended description of this species. It varies to some extent in the sculpture, and I at first inclined to separate it into two, and named the second *"curticauda,"* but further examination showed that the differences were insufficient to justify that course.

Distinguished chiefly by the sculpture of vertex and occiput, and by the short petiole and terebra.

STEPHANUS ATRICEPS (Kieffer).

Stephanus tinctipes var. *atriceps* KIEFFER, Philip. Journ. Sci. § D 11 (1916) 405.

Female and male.—Frons arcuate rugose, vertex and occiput centrally arcuate rugose, laterally coarsely punctate, three strong carinæ behind the posterior ocelli; posterior margin of head bordered; antennæ about normal; neck transcarinate, apically

dorsally impressed, more than twice as long as the smooth, shining semiannular; mesonotum centrally smooth, laterally punctate, three rows of punctures distinct; central lobe of scutellum large with large marginal punctures, lateral lobes with large, not very close punctures; mesopleuræ apically above very finely transstriate and dull, otherwise punctate; metapleuræ smooth above, coarsely punctate beneath, separated by a crenulate sulcus from the reticulate punctate median segment; petiole transstriate, basally more coarsely, a little shorter than or as long as the remaining segments, second segment basally rugose; terebra in female longer than body, black with yellowish subapical band. Hind coxæ transstriate between coarser rugosities, femora bidentate, rather longer than coxæ, tibiæ as long as femora and trochanters together, compressed in basal two-fifths. Radius emitted from slightly beyond middle of stigma.

Black; cheeks sometimes, mandibles except apices, maxillary, palpi, and scape rufescent; anterior legs and hind tibiæ, sometimes also their femora and tarsi except apices red. Wings infumate, discoidal cell slightly darker.

Length, female, 17 to 23 millimeters; abdomen, 11.5 to 15; petiole, 5.5 to 7.5; terebra, 18 to 25; band, 3 to 4; apex, 1.5 to 2.5. Male, 18 millimeters; abdomen, 12; petiole, 5.5.

MINDANAO, Dapitan, Davao. (*Baker*).

I have no doubt that this is Kieffer's var. *atriceps*. It agrees in sculpture of vertex and occiput, color, and the proportions of terebra and apex. The differences from *tinctipes* Kieffer are so great as to entitle it to specific rank.

STEPHANUS TARSATUS (Sichel), female.

Megischus tarsatus SICHEL, Soc. Ent. France; Annales IV 5 (1865) 476.

Stephanus tarsatus SCHLETT., Berl. Ent. Zeit. 33 (1889) 107; ELLIOTT, Mon. of Hymenop. Fam. Stephanidæ, Proc. Zool. Soc. London (1922) 729, female.

STEPHANUS INAEQUALIS sp. nov.

Female.—Frons and vertex transrugose, the former more closely, the latter longitudinally impressed, occiput transrugose, the rugosities becoming narrower toward back of head, laterally broadly, basally narrowly smooth, posterior margin of head strongly bordered, posterior tubercles small but distinct, the usual stronger carinæ behind posterior ocelli indistinct; scape rather longer than cheeks, antennæ normal; neck apically

strongly, basally less strongly carinate, more than twice as long as the smooth, finely and diffusely punctate semiannular; mesonotum centrally smooth, laterally rugose punctate, central row of punctures large and distinct, the lateral ones indistinct; scutellum centrally smooth with large marginal punctures, lateral lobes coarsely punctate; mesopleuræ smooth above, punctate beneath, metapleuræ finely transstriate above, otherwise coarsely punctate, separated by a carina from the cribrate punctate median segment; petiole very stout, transstriate, basally rugose, much shorter than the remaining smooth, shining segments; terebra as long as body, white banded. Hind coxæ transcarinate, shorter than the smooth, bidentate femora, tibiæ longer than femora and trochanters together, compressed in basal third, metatarsi not quite three times as long as the remaining joints. Radius emitted from apical third of the stigma, distal section one and a half times as long as the proximal.

Black; head red, anterior legs rufescent; wings hyaline, stigma and nervures black-brown.

Length, 19 millimeters; abdomen, 12; petiole, 5; terebra, 19; band, 3; apex 1.5.

SIBUYAN (*Baker*).

Distinguished by the sculpture of vertex and occiput, and the short, stout petiole.

STEPHANUS PHILIPPINENSIS Ceballos.

Stephanus philippinensis, "Eos," Rev. Esp. Entom. 2 (1926) 140, female.

STEPHANUS PUNCTATUS sp. nov.

Female.—Frons granulate, vertex and occiput centrally arcuate striate, laterally coarsely punctate, latter longitudinally impressed; two strong carinæ behind posterior ocelli, posterior tubercles very small, ocellar space rugose; scape as long as cheeks, antennæ normal; neck transcarinate, apically foveate, twice as long as the smooth semiannular, which has a few lateral punctures; mesonotum with large, diffuse punctures, the central row of punctures distinct, the lateral ones only apically; scutellum smooth, with large marginal punctures, lateral lobes diffusely punctate; meso- and metapleuræ smooth above, otherwise punctate, the latter basally feebly rugose, separated by a slightly rugose sulcus and a carina from the reticulate punctate, apically carinate median segment; petiole transstriate, basally rugose,

as long as the remaining smooth segments; terebra as long as body, white banded. Hind coxæ with finer striation between transcarinæ, shorter than the smooth, bidentate femora, tibiæ longer than femora and trochanters together, compressed in basal two-fifths, metatarsi more than twice as long as the remaining joints. Radius emitted from apical third of stigma, its distal section rather longer than the proximal.

Black; head, scape, and anterior legs red, ocellar space and vertex apically black; wings subhyaline, centrally slightly darker, stigma and nervures black.

Length, 20 millimeters; abdomen, 14; petiole, 7; terebra, 20; band 4.5; apex, 2.

SIBUYAN (*Baker*).

Distinguished by the sculpture of vertex, occiput, and mesonotum, and partly by the color of the head.

STEPHANUS TINCTIPES Kieffer.

Stephanus tinctipes KIEFFER, Philip. Journ. Sci. § D 11 (1916) 403, female, male.

STEPHANUS TINCTIPES var. RUBRIPES Kieffer.

Stephanus tinctipes var. *rubripes* KIEFFER, Philip. Journ. Sci. § D 11 (1916) 405, female, male.

STEPHANUS NIGRIPES sp. nov.

Female.—Frons arcuate striate, vertex and occiput subarcuate striate, former laterally, latter basally punctate, both strongly longitudinally impressed, no distinct carinæ behind posterior ocelli, posterior margin of head bordered; scape longer than cheeks, second flagellar joint more than twice as long as first, third little longer than second; neck apically strongly, then less strongly transcarinate, more than twice as long as the smooth semiannular; mesonotum apically finely, laterally coarsely punctate, all three rows of punctures large and distinct; scutellum centrally smooth, lateral lobes coarsely punctate; meso- and metapleuræ smooth and shining above, otherwise punctate, latter more coarsely, separated by a fine punctate sulcus and a carina from the reticulate punctate median segment; petiole transstriate, basally rugose, as long as remaining segments, second segment basally finely rugose; terebra longer than body, yellowish white banded. Hind coxæ transcarinate, femora smooth, bidentate, tibiæ as long as femora and trochanters together, compressed not quite to middle, metatarsi about twice

as long as the remaining joints. Radius emitted from apical third of stigma, its distal section one and a half times as long as the proximal.

Black; head light red, anterior legs and hind tarsi rufescent basally. Wings infumate, centrally slightly darker.

Length, 17 millimeters; abdomen, 11; petiole, 5.5; terebra, 20; band, 3.5; apex, 1.5.

MINDANAO, Surigao (*Baker*).

Agrees in some respects with *S. aequalis* mihi, especially in the absence of the usual stronger carinæ on vertex, but differs in the longer and slenderer petiole, infumate wings, and in color.

STEPHANUS AEQUALIS sp. nov.

Female and male.—Frons coarsely transrugose, vertex and occiput centrally more or less broadly transstriate, laterally reticulate punctate, former centrally impressed, posterior margin of head finely bordered, three costæ behind posterior ocelli, ocellar space centrally smooth, otherwise rugose; posterior tubercles small; scape longer than cheeks, antennæ subnormal, third flagellar joint slightly shorter than first and second together; neck coarsely transrugose, semiannular smooth, finely and diffusely punctate; mesonotum centrally smooth, laterally coarsely punctate, three rows of punctures distinct; central lobe of scutellum smooth with a few punctures, lateral lobes coarsely but not closely punctate; meso- and metapleuræ smooth above, otherwise punctate, latter more coarsely, separated by a sulcus and a carina from the median segment, which is cribrate punctate, apically more or less distinctly bicarinate; petiole basally rugose, then transstriate to the rather broadly smooth apex, as long as or very slightly shorter than the remaining smooth segments; terebra in female longer than body, white banded. Hind coxæ transcarinate, apically transstriate, about as long as the smooth, bidentate femora, tibiæ about as long as femora and trochanters together, compressed in basal two-fifths, metatarsus about twice as long as the remaining joints in female, as long in male. Radius emitted from beyond middle of stigma, its proximal section little shorter than the distal.

Black; head, scape, and legs red, apex of mandibles and compressed part of hind tibiæ black. In male the legs are somewhat darker, also sometimes the hind femora in female, but the characteristic bicolored hind tibiæ are always unmistakable.

Length, female, 16 to 32 millimeters; abdomen, 11 to 21; petiole, 5.5 to 10.5; terebra, 19 to 40; band, 3.5 to 5.5; apex, 1.5 to 3.5. Male, 14 to 22 millimeters.

Dapitan, Davao, Kolambugan, Basilan Island, Malinao, Tayabas (*Baker*).

STEPHANUS AEQUALIS var. RUFICAUDA var. nov.

Female.—Agrees in sculpture with the type, but the scutellum, median segment, and terebra are paler, rufescent, the explanate part of the hind tibiæ and their tarsi testaceous and the hind femora darker.

MINDANAO, Dapitan (*Baker*).

Very much like *S. similis* mihi, differing especially in the smooth semiannular and the bicolored hind tibiæ.

STEPHANUS IMPRESSUS Elliott.

Stephanus impressus ELLIOTT, Philip. Journ. Sci. 29 (1926) 519, female.

STEPHANUS SULCATUS Elliott.

Stephanus sulcatus ELLIOTT, Philip. Journ. Sci. 29 (1926) 521, female.

STEPHANUS DUCALIS Westwood, female, male.

Megischus ducalis WESTWOOD, Trans. Ent. Soc. London II 1 (1851).
Stephanus ducalis SCHLETT., Berl. Ent. Zeit. 33 (1889) 112; ELLIOTT, Mon. of Hymenop. Fam. Stephanidæ, Proc. Zool. Soc. London (1922) 740, female.

STEPHANUS GLABRICOXIS sp. nov.

Female.—Frons strongly arcuate striate, vertex centrally impressed and transstriate, laterally punctate, occiput centrally strongly, laterally more finely transstriate, three carinæ behind posterior ocelli, posterior tubercles distinct, ocellar space smooth and shining below the ocellus, otherwise rugose; scape longer than cheeks (antennæ broken off); neck and apex of semiannular transcarinate, latter basally broadly smooth; mesonotum rather elongate, basally and apically punctate, central row of punctures distinct, lateral ones indicated by an apical impression and a few punctures; scutellum centrally smooth, lateral lobes coarsely punctate; meso- and metapleuræ smooth above, otherwise punctate, latter separated by a carina from the cribrate punctate median segment; terebra longer than body, tricolored. Hind coxæ with transcarinæ wide apart, the space between them on dorsal two-thirds smooth and shining, apically and laterally finely transstriate, somewhat rugose beneath; femora bidentate, longer than coxæ, tibiæ as long as femora and trochanters to-

gether, compressed about to middle, metatarsi twice as long as the remaining joints. Radius emitted from beyond middle of stigma, its distal section little longer than the proximal.

Rufescent; head red, pronotum except apex, mesonotum, and abdomen from second segment more or less nigrescent, anterior tibiæ paler, front tarsi clothed with short white hairs. Terebra basally black, then rufescent to an indistinct whitish band, about 5 millimeters broad, and apically black. Wings lightly infumate, centrally much darker.

Length, 21 millimeters; abdomen, 14; petiole, 6; terebra, 25.

BORNEO, Sandakan (*Baker*).

The sculpture of the hind coxæ and the color, especially that of the terebra, are distinctive.

STEPHANUS COLLECTIVUS sp. nov.

Female.—Frons arcuate striate, vertex and occiput with central longitudinal transstriate impression not reaching base of head, remainder reticulate punctate, occiput basally laterally finely obliquely striate, three carinæ behind posterior ocelli, posterior margin of head bordered; scape rather longer than cheeks, antennæ normal; neck short, apically coarsely, basally, and the semiannular apically finely transstriate, latter basally smooth; mesonotum apically punctate, central row of punctures only distinct, laterally coarsely, confluently punctate; scutellum centrally smooth with large marginal punctures, lateral lobes closely punctate; meso- and metapleuræ smooth above, otherwise punctate, latter separated only by a smooth sulcus from the median segment, which is reticulate punctate, the apical third coarsely transrugose; petiole transstriate, basally scarcely more coarsely, stout, and much shorter than the remaining smooth shining segments; terebra much longer than body, white banded. Hind coxæ coarsely transstriate, shorter than the smooth, bidentate femora, tibiæ not much longer than the femora, compressed in basal two-fifths, metatarsi not quite three times as long as the remaining joints. Radius emitted from just beyond middle of stigma, its distal section barely one and a half times as long as the proximal.

Pro- and mesonotum and scutellum black, median segment, abdomen, and anterior legs rufescent, head, scape, and first flagellar joint dark red; wings centrally darker, stigma and nervures red-brown.

Length, 20 millimeters; abdomen, 13.5; petiole, 4.5; terebra, 27; band, 5; apex, 2.

This species appears to combine the characters of several others; the sculpture of the head closely resembles that of *S. punctatus;* it has a short neck, like *S. quadraticollis;* the semiannular is as in *S. similis,* and the short petiole as in *S. petiolatus,* with color much like that of *S. ruber.*

STEPHANUS SIMILIS sp. nov.

Female and male.—Frons and vertex arcuate striate, occiput centrally impressed, arcuate rugose, becoming more transverse toward the finely bordered posterior margin of head, three or four strong carinæ behind the posterior ocelli, posterior tubercles small but distinct; scape as long as cheeks, third flagellar joint slightly shorter than first and second together; neck transcarinate, semiannular transstriate, basally more or less broadly smooth, laterally finely punctate; mesonotum centrally smooth with a few large punctures, and distinct central row; laterally coarsely punctate, with two shallow impressions and indistinct lateral rows of punctures; scutellum centrally smooth with a few large punctures, lateral lobes coarsely but not closely punctate; meso- and metapleuræ smooth above, otherwise punctate, latter more coarsely, separated by a crenulate sulcus from the cribrate punctate, apically carinate median segment; petiole in female basally coarsely, then more finely transstriate to the broadly smooth apex, shorter than rest of abdomen; in male basally rugose, remainder smooth, sometimes finely punctate beneath, second segment basally rugose in both sexes; terebra in female longer than body, white banded. Hind coxæ transcarinate, femora bidentate, as long as coxæ and trochanters, tibiæ as long as femora and trochanters, compressed in basal two-fifths, metatarsi in female not quite twice as long as the remaining joints, in male about as long. Radius emitted from apical third of stigma, both sections of equal length.

Black; head, scape, apex of pronotum, and anterior legs red. Wings infumate, centrally darker, stigma and nervures rufescent.

Length, female, 18 to 35 millimeters; abdomen, 12 to 23; petiole, 5 to 10; terebra, 21 to 34; band, 4 to 9; apex, 1.5 to 4. Male, 12 to 25 millimeters; abdomen, 9.5 to 13; petiole, 4 to 7.

Dapitan, Surigao, Davao, Zamboanga, Mindanao, Sandakan, Borneo (*Baker*).

This species strongly resembles *S. ducalis* Westwood, but differs in the sculpture of the mesonotum and mesopleuræ, and in the color of the legs.

STEPHANUS PETIOLATUS sp. nov.

Female.—Frons, vertex, and occiput arcuate striate, vertex centrally impressed, two or three strong carinæ behind posterior ocelli, posterior tubercles subobsolete, ocellar space rugose, posterior margin of head finely bordered; scape longer than cheeks, third flagellar joint shorter than first and second together; neck transcarinate, semiannular smooth, laterally punctate; mesonotum with three distinct rows of punctures, laterally coarsely punctate; scutellum normal; meso- and metapleuræ smooth above, otherwise punctate, latter separated by an indistinct sulcus from the reticulate punctate median segment; petiole short and very stout, basally rugose, then finely transstriate to the broadly smooth apex, much shorter than the remaining segments, second segment basally rugose; terebra longer than body, white banded. Hind coxæ transcarinate, as long as the smooth, bidentate femora, tibiæ as long as femora and trochanters together, metatarsi not quite twice as long as the remaining joints. Radius emitted from apical third of stigma, its proximal section little shorter than the distal.

Male.—Neck basally smooth, passing imperceptibly into the smooth semiannular; the stout petiole very finely transstriate and the metatarsi only as long as the remaining joints. Otherwise as in female.

Black; head, scape, and legs red, hind tibiæ basally darker; in male the hind tibiæ are black, with red tarsi. Wings centrally infumate, stigma and nervures red-brown.

Length, female, 25 millimeters; abdomen, 16; petiole, 6; terebra, 31; band, 5; apex 2.5. Male, 20 millimeters; abdomen, 13; petiole, 5.

MINDANAO, Surigao (*Baker*).

This species has a strong resemblance to *S. aequalis* mihi, but differs chiefly in the short, stout petiole.

STEPHANUS PANAYANUS sp. nov.

Female.—Frons subarcuate rugose, vertex and occiput irregularly rugose, latter with central longitudinal carina, posterior margin of head finely bordered, posterior tubercles small but distinct; scape slightly longer than cheeks, antennæ normal; neck rather long, apically transcarinate, basally transstriate, semiannular smooth; mesonotum punctate, central row of punctures distinct throughout, lateral ones apically only; scutellum smooth, lateral lobes diffusely punctate; meso- and metapleuræ smooth above, the former finely, the latter coarsely punctate

beneath, separated by a carina from the reticulate punctate median segment; petiole transstriate, basally more coarsely, shorter than the rest of abdomen, second segment basally rugose; terebra longer than body, yellowish banded. Hind coxæ transcarinate, femora smooth, bidentate, as long as coxæ and trochanters, tibiæ compressed nearly to middle, metatarsi more than twice as long as the remaining joints. Radius emitted from apical third of stigma, its distal section half as long again as the proximal.

Black; head red, anterior legs, hind trochanters, and tarsi dark red; wings hyaline, centrally feebly infuscate.

Length, 25 millimeters; abdomen, 17 petiole, 8; terebra, 32.

NORTHWESTERN PANAY (*Baker*).

The carinate occiput is peculiar.

STEPHANUS RUBER sp. nov.

Female and male.—Frons, vertex, and occiput finely and evenly subarcuate striate, the vertex centrally impressed, posterior margin of head finely bordered, posterior tubercles very small; scape longer than cheeks, antennæ normal, neck apically transcarinate, basally more finely transstriate, twice as long as the smooth semiannular; mesonotum centrally smooth with three distinct rows of punctures, laterally with broad, deep impressions; meso- and metapleuræ narrowly smooth above, otherwise punctate, latter separated by a crenulate sulcus from the lightly reticulate punctate median segment; petiole finely transstriate, rather shorter than the remaining smooth, shining segments; terebra in female longer than body, white banded. Hind coxæ finely transstriate between coarser transrugosities, rather shorter than the bidentate femora, tibiæ rather longer than the femora and trochanters together, compressed not quite to middle, metatarsi three times as long as the remaining joints in female, about as long in male. Radius emitted from distal third of stigma, its proximal section more than half as long as the distal.

Dark red, anterior legs lighter, head and two basal antennal joints rufotestaceous, pronotum often black. Wings lightly infumate, stigma and nervures brown-red.

Length, female, 17.5 to 24 millimeters; abdomen, 11.5 to 16; petiole, 5 to 7; terebra, 20 to 25; band, 3.5 to 4; apex, 1.5 to 2. Male, 14 to 23 millimeters; abdomen, 9.5 to 16:5; petiole, 4 to 7.5.

Surigao, Dapitan. Sandakan (*Baker*).

The even striation of frons, vertex, and occiput is unusual; the color is very constant.

STEPHANUS RETICULATUS Elliott.

Stephanus reticulatus ELLIOTT, Philip. Journ. Sci. 29 (1926) 510, female.

In some of the female specimens the three rows of punctures on the mesonotum are very distinct, and the hind tarsi are nigrescent.

The male corresponds with the female in sculpture and color, except that the central striation on vertex and occiput is rather more extended, and the lateral puncturation restricted.

Length, female, 19 to 26 millimeters; abdomen, 12 to 17; petiole, 5 to 8; terebra, 22 to 24; band, 4 to 4.5; apex, 2 to 2.5. Male, 21 millimeters; abdomen, 14; petiole, 6.5.

STEPHANUS VARIANTIUS Elliott.

Stephanus variantius ELLIOTT, Philip. Journ. Sci. 29 (1926) 518, female.

Male.—Agrees in sculpture with the female from the same locality, except that the lateral rows of punctures on the mesonotum are more distinct.

Black; head, scape, anterior legs, hind trochanters, and tarsi red; wings basally lightly infumate, apically hyaline.

Length, 16 millimeters; abdomen, 11; petiole, 5.

MINDANAO, Davao (*Baker*).

STEPHANUS CORONATOR (Fabricius), female, male.

Pimpla coronator FABRICIUS, Systema Piezatorum (1804).
Stephanus coronator auct.

STEPHANUS SAMARIS sp. nov.

Female.—Frons, vertex, and occiput arcuate striate, frons apically and occiput basally more transversely, latter longitudinally impressed, posterior margin of head finely bordered, three carinæ behind posterior ocelli; scape longer than cheeks, second flagellar joint twice as long as first, third little longer than second; neck apically carinate, basally transstriate, twice as long as the smooth semiannular; mesonotum centrally smooth, laterally rugose, central row of punctures distinct, lateral ones apically only; scutellum normal; meso- and metapleuræ smooth above, otherwise punctate, former basally more rugose; median segment evenly and not deeply punctate; petiole transstriate, basally rugose, shorter than the rest of abdomen, second segment basally rugose; terebra longer than body, white banded. Hind coxæ transrugose, femora bidentate, tibiæ as long as femora and trochanters together, compressed in basal two-fifths, meta-

tarsi twice as long as the remaining joints. Radius emitted from slightly beyond middle of stigma, its distal section half as long again as the proximal.

Black; head, scape, and anterior legs red, apex of pronotum rufotestaceous. Wings centrally darker.

Length, 19 to 22 millimeters; abdomen, 12 to 15; petiole, 5 to 7; terebra, 22 to 25; band, 4; apex, 2.

SAMAR (*Baker*).

This may well be an insular variety of *S. coronator* Fabricius, from which it appears to differ chiefly in the rather fine sculpture of the head, metapleuræ, and median segment, and the shorter petiole.

STEPHANUS RUGICAPUT sp. nov.

Male.—Frons coarsely arcuate striate, vertex and occiput arcuate carinate, three stronger carinæ behind posterior ocelli, posterior tubercles small but distinct, posterior margin of head bordered; scape as long as cheeks, antennæ normal; neck apically strongly, basally less strongly carinate, semiannular smooth; mesonotum centrally smooth, laterally rugose, central row of punctures distinct throughout, lateral ones apically only; scutellum normal; mesopleuræ punctate, metapleuræ smooth above, coarsely punctate beneath, separated by a carina and a transstriate sulcus from the cribrate punctate median segment; petiole transstriate, slightly shorter than the remaining smooth, shining segments. Hind coxæ transstriate between coarse rugosities, femora smooth, bidentate, as long as coxæ and trochanters together, tibiæ much longer than femora, compressed not quite to middle, metatarsi a little longer than the remaining joints. Radius emitted from end of second third of stigma, its proximal section half as long as the distal.

Black; legs rufescent, apices of hind tibiæ and their tarsi paler.

Length, 14 millimeters; abdomen, 9.5; petiole, 4.5.

MINDANAO, Davao (*Baker*).

This species greatly resembles *S. variantius* mihi, and may be a form of the male.

STEPHANUS TRICOLOR sp. nov.

Male.—Frons, vertex, and occiput irregularly rugose, posterior margin of head lightly bordered, posterior tubercles small but distinct; scape longer than cheeks, antennæ normal; neck transcarinate, about twice as long as the smooth, finely and diffusely punctate semiannular; mesonotum laterally coarsely

punctate, central row of punctures distinct, lateral ones less so, with apical foveæ; central lobe of scutellum smooth with fine marginal punctures, lateral lobes with large, but not close punctures; meso- and metapleuræ smooth above, former finely, latter coarsely punctate beneath, separated by a carina from the reticulate punctate median segment; basal third of petiole rugose, remainder smooth, shorter than rest of abdomen. Hind coxæ transcarinate, apical third transstriate, about as long as the smooth bidentate femora, tibiæ about one-third longer than the femora, compressed in basal third, metatarsus as long as the remaining joints. Radius emitted from beyond middle of stigma, the distal section not quite twice as long as the proximal.

Black; petiole and abdomen rufescent, all coxæ and trochanters black, compressed part of hind tibiæ brown, remainder of legs bright rufotestaceous. Wings lightly and evenly infumate, stigma and nervures rufescent.

Length, 17.5 millimeters; abdomen, 12; petiole, 5.

Kaiser Wilhelmsland, Bongu, New Guinea.

In the sculpture of the head and petiole and the color of the hind tibiæ, this species recalls *S. aequalis* mihi, but the locality makes it improbable that it can be an insular variety of that species.

STEPHANUS RUFUS sp. nov.

Male.—Frons arcuate striate, two carinæ behind posterior ocelli, vertex, and occiput trans-striate, lightly longitudinally impressed, latter laterally punctate, posterior margin of head extremely finely bordered; scape a little longer than cheeks, antennæ normal; neck elongate, anterior half smooth, deeply foveate, basal half finely transstriate, semiannular smooth; mesonotum smooth, with deep smooth central longitudinal impression, laterally rugose punctate, lateral rows of punctures distinct; scutellum normal; meso- and metapleuræ smooth above, otherwise punctate, latter separated by a weak carina from the reticulate punctate median segment; petiole transstriate, shorter than the remaining smooth segments. Hind coxæ transstriate, as long as the smooth, bidentate femora, tibiæ about as long as the femora and trochanters together, compressed nearly to middle, metatarsi as long as the remaining joints. Radius emitted from beyond middle of stigma, its distal section little longer than the proximal.

Rufescent; scutellum, petiole, hind coxæ, and femora darker; head, scape, and first flagellar joint dark rufotestaceous.

Length, 14 millimeters; abdomen, 9; petiole, 4.

MINDANAO, Zamboanga (*Baker*).

STEPHANUS LEPIDUS sp. nov.

Male.—Frons arcuate rugose, three carinæ behind posterior ocelli, ocellar space, vertex, and occiput rugose, posterior margin of head bordered; scape about as long as cheeks, more than twice as long as first flagellar joint, antennæ normal, very slender and the joints indistinctly discrete; neck elongate, the apical half transcarinate, basal half smooth and gradually merging into the smooth semiannular; mesonotum diffusely punctate, the central row of punctures only distinct; central lobe of scutellum smooth with diffuse marginal punctures, lateral lobes not very closely punctate; meso- and metapleuræ smooth above, otherwise punctate, latter separated by a carina from the median segment, which is superficially reticulate punctate, the bottom of the punctures finely punctate; petiole finely transstriate, much shorter than the rest of abdomen. Hind coxæ transrugose, their femora smooth, bidentate, as long as the coxæ, tibiæ as long as femora and trochanters together, compressed not quite to middle. Radius emitted from apical third of stigma, distal section twice as long as the proximal.

Black; head and two basal antennal joints red, anterior legs and tegulæ rufescent; wings infumate.

Length, 16 millimeters; abdomen, 10.5; petiole, 4.

SIBUYAN (*Baker*).

A slender insect. The formation and sculpture of the pronotum are distinctive.

STEPHANUS LINEARIS sp. nov.

Male.—Frons basally rugose, apically transstriate, vertex and occiput superficially rugose punctate, latter basally narrowly smooth, posterior margin of head bordered, two arcuate carinæ and a short straight one behind the posterior ocelli, posterior tubercles distinct; scape longer than cheeks, third flagellar joint longer than second, but shorter than first and second together; pronotum rather elongate, transstriate, semiannular basally broadly smooth; mesonotum punctate, central impression distinct, lateral ones apically only; mesopleuræ smooth above, otherwise punctate, metapleuræ apically smooth above, basally and laterally coarsely punctate, separated by a line of punctures and an indistinct carina from the reticulate punctate median segment; petiole transstriate, basally more coarsely, only half as long as

the remaining narrow, shining segments. Hind coxæ rather coarsely transstriate, shorter than the smooth, bidentate femora, tibiæ nearly as long as femora and trochanters together, compressed to middle, metatarsi as long as the remaining joints. Radius emitted from far beyond middle of stigma, its distal section fully three times as long as the proximal. The cubital cell very large.

Black; head and apex of pronotum light red, abdomen from second segment rufous, with indistinct dusky basal marks on the segments; scape and legs rufescent.

Length, 10.5 millimeters; abdomen, 6; petiole, 2.

BORNEO, Sandakan (*Baker*).

The sculpture of the head and the color of the abdomen are peculiar, and it is rather small for this subfamily. Possibly a small *S. curtus*.

STEPHANUS HIRSUTUS sp. nov.

Male.—Frons coarsely arcuate striate, vertex and occiput rugose, three carinæ behind posterior ocelli, all tubercles distinct, posterior margin of head bordered; scape longer than cheeks, third flagellar joint little longer than second; neck normal, transcarinate, semiannular smooth; mesonotum lightly punctate, three rows of punctures distinct; scutellum normal; mesopleuræ punctate, metapleuræ smooth above, otherwise strongly punctate, separated by a carina from the reticulate punctate median segment; petiole transstriate, basally more coarsely, shorter than the remaining smooth, shining segments. Hind coxæ coarsely transstriate, femora bidentate, as long as coxæ and trochanters together, tibiæ longer than femora, compressed in basal two-fifths, metatarsi about as long as the remaining joints. Pleuræ, petiole, and legs with rows of long whitish hairs. Radius emitted from end of second third of stigma, its distal section half as long again as the proximal.

Black; head, scape, anterior legs, apices of hind tibiæ and their tarsi red. Wings lightly infumate, centrally darker.

Length, 17 millimeters; abdomen, 11; petiole, 5.

MINDANAO, Davao (*Baker*).